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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 **PCL CONSTRUCTION SERVICES, INC.**, a Colorado corporation ("**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 task orders issued under Contract No. 201951778, Concourse A and C Pre-Conditioned Air Re-Life 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 proposers; 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 subject to the terms of this Contracts, the Parties agree as follows:

ARTICLE I. 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
- Request for Proposals
- Notice to Proceed
- Form of Final Receipt
- Building Information Modeling ("**BIM**") if applicable
- Change Directives
- Change Orders
- Exhibit A Federal Appendices
- Exhibit B Equal Employment Opportunity Provisions
- Exhibit C Insurance Requirements
- Exhibit D Prevailing Wage Schedules
- Exhibit E Special Conditions

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- 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 Article I through XXXI 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. Exhibit K Invitation for Bids and Contractor's Response to Invitation for Bids
4. Change Directives
5. Change Orders
6. Exhibit B Equal Employment Opportunity Provisions
7. Exhibit E Special Conditions
8. Exhibit F Standard Specifications for Construction General Contract Conditions (2011 Edition) (the "**Yellow Book**") ("**General Conditions**") (Table of Contents attached as Exhibit F)
9. Exhibit C Insurance Requirements
10. Exhibit D Prevailing Wage Schedules
11. Exhibit I Technical Specifications
12. Exhibit J Contract Drawings
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.

ARTICLE II. 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**").

ARTICLE III. TERM OF CONTRACT

The Senior Vice President of Aviation – Airport Infrastructure Management (the "**SVP-AIM**") will issue a written notice to proceed to Contractor (the "**Notice to Proceed**"), and Contractor shall begin performing the Work required under this Contract within ten (10) days of

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such Notice to Proceed (the "**Commencement Date**"). Contractor shall fully complete the Work in its entirety within 548 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.

ARTICLE IV. TERMS OF PAYMENT

The City agrees to pay Contractor for the performance and completion of all of the Work as required by the Scope of Work and the Contract Documents, and Contractor agrees to accept as its full and only compensation therefor, a total amount of **Seventeen Million, One Hundred Thousand Dollars and No Cents** (**$17,100,000.00**) (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.

ARTICLE V. VERIFIED STATEMENT OF CLAIMS

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

ARTICLE VI. DISPUTES

All disputes arising under or related to this Contract shall be resolved by administrative hearing under the procedures described in Denver Revised Municipal Code Section 5-17 ("**D.R.M.C**.") and all related rules and procedures. 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.

ARTICLE VII. DEFENSE AND INDEMNIFICATION

A. To the fullest extent permitted by law, the 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.

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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 Article V. 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.

ARTICLE VIII. 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.

ARTICLE IX. 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 as further set forth in the Special Conditions shall be:

Milestone	Date of Completion	Amount Per Day
Concourse A Pre-Conditioned C Air Chillers	300 calendar days from Notice to Proceed	$3,500 per day
Concourse C Pre-Conditioned Air Chillers	365 calendar days from Notice to Proceed	$3,500 per day
Concourse A Heat Exchangers	548 calendar days from Notice to Proceed	$1,000 per day
Concourse C Heat Exchangers	548 calendar days from Notice to Proceed	$1,000 per day

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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 Contractor. Additional provisions relating to liquidated damages are set forth in the Construction Contract General Conditions and Special Conditions.

ARTICLE X. 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 Contract, including any extensions of the Contract or other extended period stipulations stated in ***Exhibit C***. All certificates of insurance and any required endorsements must be received and approved by DEN Risk Management before any airport access or work commences.

B. Unless specifically excepted in writing by DEN Risk Management, if Contractor shall be using subcontractors to provide any part of the services under this Contract, Contractor shall do one of the following:

1. Include all subcontractors performing services hereunder as insureds under its required insurance and specifically list on all submitted certificates of insurance required under ***Exhibit C***; or

2. Ensure that each subcontractor provides its own insurance coverage in accordance with the requirements set forth in this Contract.

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.

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ARTICLE XI. 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.

ARTICLE XII. 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.

ARTICLE XIII. 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 his/her 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 his/her authorized representative, automatically terminate this Contract and all rights of Contractor hereunder.

ARTICLE XIV. 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 and otherwise lawfully made available for the purposes of this Contract from the City and County of Denver 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.

ARTICLE XV. 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.

ARTICLE XVI. 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.

ARTICLE XVII. NO DISCRIMINATION IN EMPLOYMENT

In connection with the performance of work under this Contract, Contractor agrees not to refuse to hire, discharge, promote or demote, or to discriminate in matters of compensation against any person otherwise qualified, solely because of race, color, religion, national origin, gender, age,

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military status, sexual orientation, gender variance, marital status, or physical or mental disability; and Contractor further agrees to insert the foregoing provision in all subcontracts hereunder.

ARTICLE XVIII. 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.

ARTICLE XIX. COMPLIANCE WITH ALL LAWS AND REGULATIONS

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 Charter, ordinances and rules and regulations of the City.

ARTICLE XX. PROMPT PAYMENT

A. The City will make monthly progress payments to the Contractor for all services performed under this Agreement based upon the Contractor's monthly invoices. Such invoices shall be in a form acceptable to the City and shall include detail of the time worked by the Contractor's own personnel, billings from subcontractors, and all other information necessary to assess the Contractor's progress. Invoices shall be accompanied by documentation of expenses for which reimbursement is sought, and all other supporting documentation required by the City. The City's Prompt Payment Ordinance, §§ 20-107 to 20-118, D.R.M.C., applies to invoicing and payment under this Agreement.

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 are delivered to the City, and the Agreement is otherwise fully performed by the Contractor. The City may, at the discretion of the Director, withhold reasonable amounts from billing and the entirety of the final payment until all such requirements are performed to the satisfaction of the Director. However, no deductions shall be made from the Contractor's compensation because of penalty, liquidated damages or other sums withheld from payments to contractor(s)/consultants.

ARTICLE XXI. 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 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,

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and devices used in the preparation for or performance of any of the scope of work, for up to three (3) years after termination of this Contract. Upon written request from the City, Contractor shall deliver any information requested pursuant to this Article within ten (10) business days in the event a schedule or otherwise agreed-upon timeframe does not exist.

ARTICLE XXII. 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 Article V.

ARTICLE XXIII. 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 the City's election in paper or electronic form, any pertinent books, documents, papers and records related to Contractor's performance pursuant to this Contract, provision of any goods or services to the City, and any other transactions related to this Contract. Contractor shall cooperate with City representatives and City representatives shall be granted access to the foregoing documents and information during reasonable business hours and until the latter of three (3) years after the final payment under the Contract or expiration of the applicable statute of limitations. When conducting an audit of this Contract, the City Auditor shall be subject to government auditing standards issued by the United States Government Accountability Office by the Comptroller General of the United States, including with respect to disclosure of information acquired during the course of an audit. No examination of records and audits pursuant to this paragraph shall

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require Contractor to make disclosures in violation of state or federal privacy laws. Contractor shall at all times comply with D.R.M.C. § 20-276.

B. Additionally, Contractor agrees until the expiration of three (3) years after the final payment under this Contract, any duly authorized representative of the City, including the CEO or his or her 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 Consultant'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.

ARTICLE XXIV. PREVAILING WAGE REQUIREMENTS

A. Contractor shall comply with all applicable prevailing wage requirements, including the Davis-Bacon Act as further provided in Appendix A, § A.10, and all requirements, conditions and determinations of the City regarding the Payment of Prevailing Wages Ordinance, D.R.M.C. §§20-76 through 20-79, to the extent applicable in addition to Appendix A, 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: February 21, 2020.

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

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

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

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

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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.

ARTICLE XXV. MINIMUM WAGE REQUIREMENTS

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

ARTICLE XXVI. COMPLIANCE WITH DISADVANTAGED ENTERPRISE REQUIREMENTS

This Department of Transportation (DOT) 49 CFR Part 26 ("Part 26") applies to this Project and will be incorporated into any agreement entered into by the City and contained in County of Denver Bid Documents. It is the policy of DOT and the City and County of Denver to ensure non-discrimination in the award and administration of DOT-assisted contracts financed in whole or in part with Federal funds. Consequently, the Bidders must fully comply with the DBE requirements of Part 26 in bidding and performing hereunder.

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

In accordance with the requirements of the Part 26, the Contractor is committed to, at a minimum, meeting the participation goal of fifteen percent (15%) established for this Project utilizing properly certified DBE subcontractors and suppliers.

ARTICLE XXVII. 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

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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 the DEN's Security Office.

ARTICLE XXVIII. DEN SECURITY

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

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

ARTICLE XXIX. 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 Denver Municipal Airport System. Certain Federal requirements are specified in Exhibit A.

1. 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 subtier contractors 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.

2. 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

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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.

3. 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.

4. 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 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 City to enter into any litigation to protect the interests of City. In addition, Contractor may request the United States to enter into the litigation to protect the interests of the United States.

ARTICLE XXX. 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.

ARTICLE XXXI. 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.

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Contract Control Number: PLANE-201951778-00
Contractor Name: PCL CONSTRUCTION SERVICES, INC.

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: _____

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Contract Control Number: PLANE-201951778-00
Contractor Name: PCL CONSTRUCTION SERVICES, INC.

By: DocuSigned by: Ryan Schmidt 3E5699C94A324CA...

Name: Ryan Schmidt
(please print)

Title: Distrcit Manager
(please print)

ATTEST: [if required]

By: _____

Name: _____
(please print)

Title: _____
(please print)

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EXHIBIT A

FEDERAL CONSTRUCTION CONTRACT PROVISIONS

A1 ACCESS TO RECORDS AND REPORTS

A1.3 ACCESS TO RECORDS AND REPORTS

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

A2 AFFIRMATIVE ACTION REQUIREMENT

A2.3 NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION to ENSURE EQUAL EMPLOYMENT OPPORTUNITY

1. The Offeror's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Opportunity Construction Contract Specifications" set forth herein.

2. The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Timetables
Goals for minority participation for each trade: **[*sponsor must insert established goal*]**

Goals for female participation in each trade: 6.9%

These goals are applicable to all of the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the Contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the Contractor also is subject to the goals for both its federally involved and non-federally involved construction.

The Contractor's compliance with the Executive Order and the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a) and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform

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throughout the length of the contract, and in each trade, and the Contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs (OFCCP) within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address, and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.

4. As used in this notice and in the contract resulting from this solicitation, the "covered area" is City and County of Denver, Colorado.

A3.3 BREACH OF CONTRACT TERMS

Any violation or breach of terms of this contract on the part of the [*Contractor* | *Consultant*] or its subcontractors may result in the suspension or termination of this contract or such other action that may be necessary to enforce the rights of the parties of this agreement.

Owner will provide Contractor written notice that describes the nature of the breach and corrective actions the Contractor must undertake in order to avoid termination of the contract. Owner reserves the right to withhold payments to Contractor until such time the Contractor corrects the breach or the Owner elects to terminate the contract. The Owner's notice will identify a specific date by which the Contractor must correct the breach. Owner may proceed with termination of the contract if the Contractor fails to correct the breach by the deadline indicated in the Owner's notice.

The duties and obligations imposed by the Contract Documents and the rights and remedies available thereunder are in addition to, and not a limitation of, any duties, obligations, rights and remedies otherwise imposed or available by law.

A4 BUY AMERICAN PREFERENCE

A4.3.1 BUY AMERICAN PREFERENCE

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

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A bidder or offeror must complete and submit the Buy America certification included herein with their bid or offer. The Owner will reject as nonresponsive any bid or offer that does not include a completed Certificate of Buy American Compliance.

A4.3.2 Certificate of Buy American Compliance – Total Facility

CERTIFICATE OF BUY AMERICAN COMPLIANCE FOR TOTAL FACILITY

As a matter of bid responsiveness, the bidder or offeror must complete, sign, date, and submit this certification statement with its proposal. The bidder or offeror must indicate how it intends to comply with 49 USC § 50101 by selecting one of the following certification statements. These statements are mutually exclusive. Bidder must select one or the other (i.e. not both) by inserting a checkmark ( ) or the letter "X".

Bidder or offeror hereby certifies that it will comply with 49 USC § 50101 by:

a) Only installing steel and manufactured products produced in the United States; or
b) Installing manufactured products for which the Federal Aviation Administration (FAA) has issued a waiver as indicated by inclusion on the current FAA Nationwide Buy American Waivers Issued listing; or
c) Installing products listed as an Excepted Article, Material or Supply in Federal Acquisition Regulation Subpart 25.108.

By selecting this certification statement, the bidder or offeror agrees:

- To provide to the Owner evidence that documents the source and origin of the steel and manufactured product.
- To faithfully comply with providing U.S. domestic products.
- To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

The bidder or offeror hereby certifies it cannot comply with the 100 percent Buy American Preferences of 49 USC § 50101(a) but may qualify for either a Type 3 or Type 4 waiver under 49 USC § 50101(b). By selecting this certification statement, the apparent bidder or offeror with the apparent low bid agrees:

a) To the submit to the Owner within 15 calendar days of the bid opening, a formal waiver request and required documentation that supports the type of waiver being requested.
b) That failure to submit the required documentation within the specified timeframe is cause for a non-responsive determination that may result in rejection of the proposal.
c) To faithfully comply with providing U.S. domestic products at or above the approved U.S. domestic content percentage as approved by the FAA.
d) To furnish U.S. domestic product for any waiver request that the FAA rejects.

To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

Required Documentation

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Type 3 Waiver – The cost of components and subcomponents produced in the United States is more than 60 percent of the cost of all components and subcomponents of the "facility". The required documentation for a Type 3 waiver is:

a) Listing of all manufactured products that are not comprised of 100 percent U.S. domestic content (excludes products listed on the FAA Nationwide Buy American Waivers Issued listing and products excluded by Federal Acquisition Regulation Subpart 25.108; products of unknown origin must be considered as non-domestic products in their entirety).
b) Cost of non-domestic components and subcomponents, excluding labor costs associated with final assembly and installation at project location.
c) Percentage of non-domestic component and subcomponent cost as compared to total "facility" component and subcomponent costs, excluding labor costs associated with final assembly and installation at project location.

Type 4 Waiver – Total cost of project using U.S. domestic source product exceeds the total project cost using non-domestic product by 25 percent. The required documentation for a Type 4 of waiver is:

a) Detailed cost information for total project using U.S. domestic product
b) Detailed cost information for total project using non-domestic product

False Statements: Per 49 USC § 47126, this certification concerns a matter within the jurisdiction of the Federal Aviation Administration and the making of a false, fictitious or fraudulent certification may render the maker subject to prosecution under Title 18, United States Code.

Date	Signature
Company Name	Title

A4.3.3 Certificate of Buy American Compliance – Manufactured Product

Certificate of Buy American Compliance for Manufactured Products

As a matter of bid responsiveness, the bidder or offeror must complete, sign, date, and submit this certification statement with their proposal. The bidder or offeror must indicate how they intend to comply with 49 USC § 50101 by selecting one on the following certification statements. These statements are mutually exclusive. Bidder must select one or the other (not both) by inserting a checkmark ( ) or the letter "X".

Bidder or offeror hereby certifies that it will comply with 49 USC § 50101 by:

a) Only installing steel and manufactured products produced in the United States;

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b) Installing manufactured products for which the Federal Aviation Administration (FAA) has issued a waiver as indicated by inclusion on the current FAA Nationwide Buy American Waivers Issued listing; or
c) Installing products listed as an Excepted Article, Material or Supply in Federal Acquisition Regulation Subpart 25.108.

By selecting this certification statement, the bidder or offeror agrees:

1. To provide to the Owner evidence that documents the source and origin of the steel and manufactured product.
2. To faithfully comply with providing U.S. domestic product.
3. To furnish U.S. domestic product for any waiver request that the FAA rejects
4. To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

The bidder or offeror hereby certifies it cannot comply with the 100 percent Buy American Preferences of 49 USC § 50101(a) but may qualify for either a Type 3 or Type 4 waiver under 49 USC § 50101(b). By selecting this certification statement, the apparent bidder or offeror with the apparent low bid agrees:

1. To the submit to the Owner within 15 calendar days of the bid opening, a formal waiver request and required documentation that supports the type of waiver being requested.
2. That failure to submit the required documentation within the specified timeframe is cause for a non-responsive determination may result in rejection of the proposal.
3. To faithfully comply with providing U.S. domestic products at or above the approved U.S. domestic content percentage as approved by the FAA.
4. To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

Required Documentation

Type 3 Waiver – The cost of the item components and subcomponents produced in the United States is more that 60 percent of the cost of all components and subcomponents of the “item”. The required documentation for a Type 3 waiver is:

a) Listing of all product components and subcomponents that are not comprised of 100 percent U.S. domestic content (Excludes products listed on the FAA Nationwide Buy American Waivers Issued listing and products excluded by Federal Acquisition Regulation Subpart 25.108; products of unknown origin must be considered as non-domestic products in their entirety).
b) Cost of non-domestic components and subcomponents, excluding labor costs associated with final assembly at place of manufacture.
c) Percentage of non-domestic component and subcomponent cost as compared to total “item” component and subcomponent costs, excluding labor costs associated with final assembly at place of manufacture.

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Type 4 Waiver – Total cost of project using U.S. domestic source product exceeds the total project cost using non-domestic product by 25 percent. The required documentation for a Type 4 of waiver is:

a) Detailed cost information for total project using U.S. domestic product
b) Detailed cost information for total project using non-domestic product

False Statements: Per 49 USC § 47126, this certification concerns a matter within the jurisdiction of the Federal Aviation Administration and the making of a false, fictitious or fraudulent certification may render the maker subject to prosecution under Title 18, United States Code.

Date	Signature
Company Name	Title

A5 CIVIL RIGHTS – GENERAL

A5.3.1 GENERAL CIVIL RIGHTS PROVISIONS

The 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 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.

A6 CIVIL RIGHTS – TITLE VI ASSURANCE

A6.3.1 Title VI Solicitation Notice

The **(Name of Sponsor)**, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 USC §§ 2000d to 2000d-4) and the Regulations, hereby notifies all bidders or offerors that it will affirmatively ensure that any contract entered into pursuant to this advertisement, [select disadvantaged business enterprises or airport concession disadvantaged business enterprises] will be afforded full and fair opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award.

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A6.4.1 Title VI Clauses for Compliance with Nondiscrimination Requirements

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

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

2. **Nondiscrimination:** The Contractor, with regard to the work performed by it during the contract, will not discriminate on the grounds of race, color, or national origin in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The Contractor will not participate directly or indirectly in the discrimination prohibited by the Nondiscrimination Acts and Authorities, including employment practices when the contract covers any activity, project, or program set forth in Appendix B of 49 CFR part 21.

3. **Solicitations for Subcontracts, including Procurements of Materials and Equipment:** In all solicitations, either by competitive bidding or negotiation made by the Contractor for work to be performed under a subcontract, including procurements of materials, or leases of equipment, each potential subcontractor or supplier will be notified by the Contractor of the contractor's obligations under this contract and the Nondiscrimination Acts and Authorities on the grounds of race, color, or national origin.

4. **Information and Reports:** The Contractor will provide all information and reports required by the Acts, the Regulations, and directives issued pursuant thereto and will permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the sponsor or the Federal Aviation Administration to be pertinent to ascertain compliance with such Nondiscrimination Acts and Authorities and instructions. Where any information required of a contractor is in the exclusive possession of another who fails or refuses to furnish the information, the Contractor will so certify to the sponsor or the Federal Aviation Administration, as appropriate, and will set forth what efforts it has made to obtain the information.

5. **Sanctions for Noncompliance:** In the event of a Contractor's noncompliance with the non-discrimination provisions of this contract, the sponsor will impose such contract sanctions as it or the Federal Aviation Administration may determine to be appropriate, including, but not limited to:

    a. Withholding payments to the Contractor under the contract until the Contractor complies; and/or
    b. Cancelling, terminating, or suspending a contract, in whole or in part.

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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.

A7 CLEAN AIR AND WATER POLLUTION CONTROL

A7.3 CLEAN AIR AND WATER POLLUTION CONTROL

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

A8 CONTRACT WORKHOURS AND SAFETY STANDARDS ACT REQUIREMENTS

A8.3 CONTRACT WORKHOURS AND SAFETY STANDARDS ACT REQUIREMENTS

1. Overtime Requirements.

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

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

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

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3. Withholding for Unpaid Wages and Liquidated Damages.

The Federal Aviation Administration (FAA) or the Owner shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (2) of this clause.

4. Subcontractors.

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

A9 COPELAND "ANTI-KICKBACK" ACT

A9.3 COPELAND "ANTI-KICKBACK" ACT

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

A10 DAVIS-BACON REQUIREMENTS

A10.3 DAVIS-BACON REQUIREMENTS

1. Minimum Wages.

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

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Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR Part 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: *Provided* that the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under (1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the Contractor and its subcontractors at the site of the work in a prominent and accessible place where it can easily be seen by the workers.

(ii)(A) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination;

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

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(C) In the event the Contractor, the laborers, or mechanics to be employed in the classification, or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to subparagraphs (1)(ii) (B) or (C) of this paragraph, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program: *Provided* that the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

2. Withholding.

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

3. Payrolls and Basic Records.

(i) Payrolls and basic records relating thereto shall be maintained by the Contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker; his or her correct classification; hourly rates of wages paid (including rates of contributions or costs anticipated for bona

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

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

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the Contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) The payroll for the payroll period contains the information required to be provided under 29 CFR § 5.5(a)(3)(ii), the appropriate information is being maintained under 29 CFR § 5.5 (a)(3)(i), and that such information is correct and complete;

(2) Each laborer and mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made

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either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations 29 CFR Part 3;

(4) Each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the Contractor or subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.

(ii) The Contractor or subcontractor shall make the records required under paragraph (3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the sponsor, the Federal Aviation Administration, or the Department of Labor and shall permit such representatives to interview employees during working hours on the job. If the Contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the Contractor, Sponsor, applicant, or Owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

4. Apprentices and Trainees.

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the Contractor's or subcontractor's

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registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, the Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination that provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate that is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal Employment Opportunity. The utilization of apprentices, trainees, and journeymen under this part shall be in conformity with the equal employment

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opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

5. Compliance with Copeland Act Requirements.

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

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

7. Contract Termination: Debarment.

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

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

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

9. Disputes Concerning Labor Standards.

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

10. Certification of Eligibility.

    (i) By entering into this contract, the Contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

    (ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

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(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 USC 1001.

A11.3 SOLICITATION CLAUSE
A11.3.1 CERTIFICATION OF OFFERER/BIDDER REGARDING DEBARMENT

By submitting a bid/proposal under this solicitation, the bidder or offeror certifies that neither it nor its principals are presently debarred or suspended by any Federal department or agency from participation in this transaction.

A11.3.2 CERTIFICATION OF LOWER TIER CONTRACTORS REGARDING DEBARMENT

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

1. Checking the System for Award Management at website: http://www.sam.gov.

2. Collecting a certification statement similar to the Certification of Offerer /Bidder Regarding Debarment, above.

3. Inserting a clause or condition in the covered transaction with the lower tier contract.

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

A12 DISADVANTAGED BUSINESS ENTERPRISE

A12.3.1 Solicitation Language (Solicitations that include a Project Goal)

Information Submitted as a matter of bidder responsiveness: The Owner's award of this contract is conditioned upon Bidder or Offeror satisfying the good faith effort requirements of 49 CFR §26.53.

As a condition of bid responsiveness, the Bidder or Offeror must submit the following information with its proposal on the forms provided herein:

1) The names and addresses of Disadvantaged Business Enterprise (DBE) firms that will participate in the contract;
2) A description of the work that each DBE firm will perform;
3) The dollar amount of the participation of each DBE firm listed under (1)

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4) Written statement from Bidder or Offeror that attests their commitment to use the DBE firm(s) listed under (1) to meet the Owner's project goal; and
5) If Bidder or Offeror cannot meet the advertised project DBE goal, evidence of good faith efforts undertaken by the Bidder or Offeror as described in appendix A to 49 CFR part 26.

Information submitted as a matter of bidder responsibility:
The Owner's award of this contract is conditioned upon Bidder or Offeror satisfying the good faith effort requirements of 49 CFR §26.53.

The successful Bidder or Offeror must provide written confirmation of participation from each of the DBE firms the Bidder or Offeror lists in its commitment within five days after bid opening.

1) The names and addresses of Disadvantaged Business Enterprise (DBE) firms that will participate in the contract;
2) A description of the work that each DBE firm will perform;
3) The dollar amount of the participation of each DBE firm listed under (1)
4) Written statement from Bidder or Offeror that attests their commitment to use the DBE firm(s) listed under (1) to meet the Owner's project goal; and
5) If Bidder or Offeror cannot meet the advertised project DBE goal, evidence of good faith efforts undertaken by the Bidder or Offeror as described in appendix A to 49 CFR part 26.

A12.3.3 DISADVANTAGED BUSINESS ENTERPRISES

Contract Assurance (§ 26.13) –

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

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

Prompt Payment (§26.29) –

The prime contractor agrees to pay each subcontractor under this prime contract for satisfactory performance of its contract no later than [specify number] days from the receipt of each payment the prime contractor receives from [Name of recipient]. The prime contractor agrees further to return retainage payments to each subcontractor within [specify the same number as above] days after the subcontractor's work is satisfactorily completed. Any delay or postponement of payment from the above referenced time frame may occur only for good cause following written

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approval of the [Name of Recipient]. This clause applies to both DBE and non-DBE subcontractors.

A13 DISTRACTED DRIVING WHEN DRIVING

In accordance with Executive Order 13513, "Federal Leadership on Reducing Text Messaging While Driving", (10/1/2009) and DOT Order 3902.10, "Text Messaging While Driving", (12/30/2009), the Federal Aviation Administration encourages recipients of Federal grant funds to adopt and enforce safety policies that decrease crashes by distracted drivers, including policies to ban text messaging while driving when performing work related to a grant or subgrant. In support of this initiative, the Owner encourages the Contractor to promote policies and initiatives for its employees and other work personnel that decrease crashes by distracted drivers, including policies that ban text messaging while driving motor vehicles while performing work activities associated with the project. The Contractor must include the substance of this clause in all sub-tier contracts exceeding $3,500 that involve driving a motor vehicle in performance of work activities associated with the project.

A14 ENERGY CONSERVATION REQUIREMENTS

A14.3 ENERGY CONSERVATION REQUIREMENTS

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

A16 EQUAL EMPLOYEMENT OPPORTUNITY (EEO)

A16.3.1 EQUAL OPPORTUNITY CLAUSE

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

(1) The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, sexual orientation, gender identify, or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff, or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
(2) The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive considerations for employment without regard to race, color, religion, sex, or national origin.
(3) The Contractor will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice to be

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provided advising the said labor union or workers' representatives of the Contractor's commitments under this section and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

(5) The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of the Contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

(7) The Contractor will include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (7) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance*: Provided, however*, that in the event a contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the administering agency the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

A16.3.2 STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS

1. As used in these specifications:

   a. "Covered area" means the geographical area described in the solicitation from which this contract resulted;

   b. "Director" means Director, Office of Federal Contract Compliance Programs (OFCCP), U.S. Department of Labor, or any person to whom the Director delegates authority;

   c. "Employer identification number" means the Federal social security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941;

   d. "Minority" includes:

      (1) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);

      (2) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin regardless of race);

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(3) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
(4) American Indian or Alaskan native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

2. Whenever the Contractor, or any subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of $10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.

3. If the Contractor is participating (pursuant to 41 CFR part 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors shall be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each contractor or subcontractor participating in an approved plan is individually required to comply with its obligations under the EEO clause and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other contractors or subcontractors toward a goal in an approved Plan does not excuse any covered contractor's or subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.
4. The Contractor shall implement the specific affirmative action standards provided in paragraphs 7a through 7p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered construction contractors performing construction work in a geographical area where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.
5. Neither the provisions of any collective bargaining agreement nor the failure by a union with whom the Contractor has a collective bargaining agreement to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.
6. In order for the non-working training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees shall be employed by the Contractor during the training period and the Contractor shall have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees shall be trained pursuant to training programs approved by the U.S. Department of Labor.

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7. The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully and shall implement affirmative action steps at least as extensive as the following:

    a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other onsite supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.
    b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.
    c. Maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source, or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefore along with whatever additional actions the Contractor may have taken.
    d. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or female sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.
    e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under 7b above.
    f. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.
    g. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility

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for hiring, assignment, layoff, termination, or other employment decisions, including specific review of these items, with onsite supervisory personnel such superintendents, general foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

h. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other contractors and subcontractors with whom the Contractor does or anticipates doing business.
i. Direct its recruitment efforts, both oral and written, to minority, female, and community organizations, to schools with minority and female students; and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations, such as the above, describing the openings, screening procedures, and tests to be used in the selection process.
j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer, and vacation employment to minority and female youth both on the site and in other areas of a contractor's workforce. k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR part 60-3.
k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR part 60-3.
l. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel, for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.
m. Ensure that seniority practices, job classifications, work assignments, and other personnel practices do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.
n. Ensure that all facilities and company activities are non-segregated except that separate or single user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.
o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.
p. Conduct a review, at least annually, of all supervisor's adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

8. Contractors are encouraged to participate in voluntary associations, which assist in fulfilling one or more of their affirmative action obligations (7a through 7p). The efforts of a contractor association, joint contractor union, contractor community, or other similar groups of which the Contractor is a member and participant may be asserted as fulfilling

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any one or more of its obligations under 7a through 7p of these specifications provided that the Contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

9. A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, if the particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally), the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized.
10. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.
11. The Contractor shall not enter into any subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246. 12. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination, and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.
13. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph 7 of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR part 60-4.8.
14. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government, and to keep records. Records shall at least include for each employee, the name, address, telephone number, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.
15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g. those under the Public

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Works Employment Act of 1977 and the Community Development Block Grant Program).

A17 FEDERAL FAIR LABOR STANDARDS ACT (FEDERAL MINIMUM WAGE)

All contracts and subcontracts that result from this solicitation incorporate by reference the provisions of 29 CFR part 201, the Federal Fair Labor Standards Act (FLSA), with the same force and effect as if given in full text. The FLSA sets minimum wage, overtime pay, recordkeeping, and child labor standards for full and part-time workers.

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

A18 LOBBYING AND INFLUENCING FEDERAL EMPLOYEES

A18.3 CERTIFICATION REGARDING LOBBYING

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

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the Bidder or Offeror, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all sub-awards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all sub-recipients shall certify and disclose accordingly.

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

A19 PROHIBITION of SEGREGATED FACILITIES

A19.3 PROHIBITION OF SEGREGATED FACILITIES

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(a) The Contractor agrees that it does not and will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not and will not permit its employees to perform their services at any location under its control where segregated facilities are maintained. The Contractor agrees that a breach of this clause is a violation of the Equal Employment Opportunity clause in this contract.

(b) "Segregated facilities," as used in this clause, means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees that are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, sex, or national origin because of written or oral policies or employee custom. The term does not include separate or single-user rest rooms or necessary dressing or sleeping areas provided to assure privacy between the sexes.

A20 OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970

A20.3 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. The employer must provide a work environment that is free from recognized hazards that may cause death or serious physical harm to the employee. The employer retains full responsibility to monitor its compliance and their subcontractor's compliance with the applicable requirements of the Occupational Safety and Health Act of 1970 (20 CFR Part 1910). The employer must address any claims or disputes that pertain to a referenced requirement directly with the U.S. Department of Labor – Occupational Safety and Health Administration.

A21 PROCUREMENT OF RECOVERED MATERIALS

A21.3 PROCUREMENT OF RECOVERED MATERIALS

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

1) The contract requires procurement of $10,000 or more of a designated item during the fiscal year; or

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2) The contractor has procured $10,000 or more of a designated item using Federal funding during the previous fiscal year.

The list of EPA-designated items is available at www.epa.gov/smm/comprehensive-procurement-guidelines-construction-products.

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

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

A24 TAX DELINQUENCY AND FELONY CONVICTIONS

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

The applicant must complete the following two certification statements. The applicant must indicate its current status as it relates to tax delinquency and felony conviction by inserting a checkmark (✓) in the space following the applicable response. The applicant agrees that, if awarded a contract resulting from this solicitation, it will incorporate this provision for certification in all lower tier subcontracts.

Certifications

The applicant represents that it is (✓) is not (✓) a corporation that has any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

The applicant represents that it is (✓) is not (✓) is not a corporation that was convicted of a criminal violation under any Federal law within the preceding 24 months.

Note

If an applicant responds in the affirmative to either of the above representations, the applicant is ineligible to receive an award unless the sponsor has received notification from the agency suspension and debarment official (SDO) that the SDO has considered suspension or debarment and determined that further action is not required to protect the Government's interests. The applicant therefore must provide information to the owner about its tax liability or conviction to the Owner, who will then notify the FAA Airports District Office, which will then notify the agency's SDO to facilitate completion of the required considerations before award decisions are made.

Term Definitions-

Felony conviction: Felony conviction means a conviction within the preceding twentyfour (24) months of a felony criminal violation under any Federal law and includes

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conviction of an offense defined in a section of the U.S. code that specifically classifies the offense as a felony and conviction of an offense that is classified as a felony under 18 U.S.C. § 3559.

Tax Delinquency: A tax delinquency is any unpaid Federal tax liability that has been assessed, for which all judicial and administrative remedies have been exhausted, or have lapsed, and that is not being paid in a timely manner pursuant to an agreement with the authority responsible for collecting the tax liability.

A25 TERMINATION OF CONTRACT

A25.3.1 TERMINATION FOR CONVENIENCE (CONSTRUCTION & EQUIPMENT CONTRACTS)

The Owner may terminate this contract in whole or in part at any time by providing written notice to the Contractor. Such action may be without cause and without prejudice to any other right or remedy of Owner. Upon receipt of a written notice of termination, except as explicitly directed by the Owner, the Contractor shall immediately proceed with the following obligations regardless of any delay in determining or adjusting amounts due under this clause:

1. Contractor must immediately discontinue work as specified in the written notice.
2. Terminate all subcontracts to the extent they relate to the work terminated under the notice.
3. Discontinue orders for materials and services except as directed by the written notice.
4. Deliver to the Owner all fabricated and partially fabricated parts, completed and partially completed work, supplies, equipment and materials acquired prior to termination of the work, and as directed in the written notice.
5. Complete performance of the work not terminated by the notice.
6. Take action as directed by the Owner to protect and preserve property and work related to this contract that Owner will take possession.

Owner agrees to pay Contractor for:

1. completed and acceptable work executed in accordance with the contract documents prior to the effective date of termination;
2. documented expenses sustained prior to the effective date of termination in performing work and furnishing labor, materials, or equipment as required by the contract documents in connection with uncompleted work;
3. reasonable and substantiated claims, costs, and damages incurred in settlement of terminated contracts with Subcontractors and Suppliers; and
4. reasonable and substantiated expenses to the Contractor directly attributable to Owner’s termination action.

Owner will not pay Contractor for loss of anticipated profits or revenue or other economic loss arising out of or resulting from the Owner’s termination action.

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The rights and remedies this clause provides are in addition to any other rights and remedies provided by law or under this contract.

TERMINATION FOR CONVENIENCE (PROFESSIONAL SERVICES)

The Owner may, by written notice to the Consultant, terminate this Agreement for its convenience and without cause or default on the part of Consultant. Upon receipt of the notice of termination, except as explicitly directed by the Owner, the Contractor must immediately discontinue all services affected.
Upon termination of the Agreement, the Consultant must deliver to the Owner all data, surveys, models, drawings, specifications, reports, maps, photographs, estimates, summaries, and other documents and materials prepared by the Engineer under this contract, whether complete or partially complete.

Owner agrees to make just and equitable compensation to the Consultant for satisfactory work completed up through the date the Consultant receives the termination notice. Compensation will not include anticipated profit on non-performed services.

Owner further agrees to hold Consultant harmless for errors or omissions in documents that are incomplete as a result of the termination action under this clause.

A25.3.2 TERMINATION FOR DEFAULT

TERMINATION FOR DEFAULT (CONSTRUCTION)

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

TERMINATION FOR DEFAULT (EQUIPMENT)

The Owner may, by written notice of default to the Contractor, terminate all or part of this Contract if the Contractor:

1. Fails to commence the Work under the Contract within the time specified in the Notice-to-Proceed;
2. Fails to make adequate progress as to endanger performance of this Contract in accordance with its terms;
3. Fails to make delivery of the equipment within the time specified in the Contract, including any Owner approved extensions;
4. Fails to comply with material provisions of the Contract;
5. Submits certifications made under the Contract and as part of their proposal that include false or fraudulent statements; or
6. Becomes insolvent or declares bankruptcy.

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If one or more of the stated events occur, the Owner will give notice in writing to the Contractor and Surety of its intent to terminate the contract for cause. At the Owner's discretion, the notice may allow the Contractor and Surety an opportunity to cure the breach or default.

If within [10] days of the receipt of notice, the Contractor or Surety fails to remedy the breach or default to the satisfaction of the Owner, the Owner has authority to acquire equipment by other procurement action. The Contractor will be liable to the Owner for any excess costs the Owner incurs for acquiring such similar equipment.

Payment for completed equipment delivered to and accepted by the Owner shall be at the Contract price. The Owner may withhold from amounts otherwise due the Contractor for such completed equipment, such sum as the Owner determines to be necessary to protect the Owner against loss because of Contractor default.

Owner will not terminate the Contractor's right to proceed with the Work under this clause if the delay in completing the work arises from unforeseeable causes beyond the control and without the fault or negligence of the Contractor. Examples of such acceptable causes include: acts of God, acts of the Owner, acts of another Contractor in the performance of a contract with the Owner, and severe weather events that substantially exceed normal conditions for the location.

If, after termination of the Contractor's right to proceed, the Owner determines that the Contractor was not in default, or that the delay was excusable, the rights and obligations of the parties will be the same as if the Owner issued the termination for the convenience the Owner.

The rights and remedies of the Owner in this clause are in addition to any other rights and remedies provided by law or under this contract.

TERMINATION FOR DEFAULT (PROFESSIONAL SERVICES)

Either party may terminate this Agreement for cause if the other party fails to fulfill its obligations that are essential to the completion of the work per the terms and conditions of the Agreement. The party initiating the termination action must allow the breaching party an opportunity to dispute or cure the breach.

The terminating party must provide the breaching party [7] days advance written notice of its intent to terminate the Agreement. The notice must specify the nature and extent of the breach, the conditions necessary to cure the breach, and the effective date of the termination action. The rights and remedies in this clause are in addition to any other rights and remedies provided by law or under this agreement.

a) **Termination by Owner**: The Owner may terminate this Agreement in whole or in part, for the failure of the Consultant to:

   1. Perform the services within the time specified in this contract or by Owner approved extension;
   2. Make adequate progress so as to endanger satisfactory performance of the Project; or

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3. Fulfill the obligations of the Agreement that are essential to the completion of the Project.

Upon receipt of the notice of termination, the Consultant must immediately discontinue all services affected unless the notice directs otherwise. Upon termination of the Agreement, the Consultant must deliver to the Owner all data, surveys, models, drawings, specifications, reports, maps, photographs, estimates, summaries, and other documents and materials prepared by the Engineer under this contract, whether complete or partially complete.

Owner agrees to make just and equitable compensation to the Consultant for satisfactory work completed up through the date the Consultant receives the termination notice. Compensation will not include anticipated profit on non-performed services.

Owner further agrees to hold Consultant harmless for errors or omissions in documents that are incomplete as a result of the termination action under this clause.

If, after finalization of the termination action, the Owner determines the Consultant was not in default of the Agreement, the rights and obligations of the parties shall be the same as if the Owner issued the termination for the convenience of the Owner.

b) **Termination by Consultant**: The Consultant may terminate this Agreement in whole or in part, if the Owner:

1. Defaults on its obligations under this Agreement;
2. Fails to make payment to the Consultant in accordance with the terms of this Agreement;
3. Suspends the Project for more than [180] days due to reasons beyond the control of the Consultant.

Upon receipt of a notice of termination from the Consultant, Owner agrees to cooperate with Consultant for the purpose of terminating the agreement or portion thereof, by mutual consent. If Owner and Consultant cannot reach mutual agreement on the termination settlement, the Consultant may, without prejudice to any rights and remedies it may have, proceed with terminating all or parts of this Agreement based upon the Owner's breach of the contract.

In the event of termination due to Owner breach, the Engineer is entitled to invoice Owner and to receive full payment for all services performed or furnished in accordance with this Agreement and all justified reimbursable expenses incurred by the Consultant through the effective date of termination action. Owner agrees to hold Consultant harmless for errors or omissions in documents that are incomplete as a result of the termination action under this clause.

A26 TRADE RESTRICTION CERTIFICATION

A26.3 TRADE RESTRICTION CERTIFICATION

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By submission of an offer, the Offeror certifies that with respect to this solicitation and any resultant contract, the Offeror –

1) is not owned or controlled by one or more citizens of a foreign country included in the list of countries that discriminate against U.S. firms as published by the Office of the United States Trade Representative (USTR);
2) has not knowingly entered into any contract or subcontract for this project with a person that is a citizen or national of a foreign country included on the list of countries that discriminate against U.S. firms as published by the USTR; and
3) has not entered into any subcontract for any product to be used on the Federal project that is produced in a foreign country included on the list of countries that discriminate against U.S. firms published by the USTR.

This certification concerns a matter within the jurisdiction of an agency of the United States of America and the making of a false, fictitious, or fraudulent certification may render the maker subject to prosecution under Title 18 USC Section 1001.

The Offeror/Contractor must provide immediate written notice to the Owner if the Offeror/Contractor learns that its certification or that of a subcontractor was erroneous when submitted or has become erroneous by reason of changed circumstances. The Contractor must require subcontractors provide immediate written notice to the Contractor if at any time it learns that its certification was erroneous by reason of changed circumstances.

Unless the restrictions of this clause are waived by the Secretary of Transportation in accordance with 49 CFR 30.17, no contract shall be awarded to an Offeror or subcontractor:

1) who is owned or controlled by one or more citizens or nationals of a foreign country included on the list of countries that discriminate against U.S. firms published by the USTR or
2) whose subcontractors are owned or controlled by one or more citizens or nationals of a foreign country on such USTR list or
3) who incorporates in the public works project any product of a foreign country on such USTR list.

Nothing contained in the foregoing shall be construed to require establishment of a system of records in order to render, in good faith, the certification required by this provision. The knowledge and information of a contractor is not required to exceed that which is normally possessed by a prudent person in the ordinary course of business dealings.

The Offeror agrees that, if awarded a contract resulting from this solicitation, it will incorporate this provision for certification without modification in all lower tier subcontracts. The Contractor may rely on the certification of a prospective subcontractor that it is not a firm from a foreign country included on the list of countries that discriminate against U.S. firms as published by USTR, unless the Offeror has knowledge that the certification is erroneous.

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This certification is a material representation of fact upon which reliance was placed when making an award. If it is later determined that the Contractor or subcontractor knowingly rendered an erroneous certification, the Federal Aviation Administration (FAA) may direct through the Owner cancellation of the contract or subcontract for default at no cost to the Owner or the FAA.

A27 VETERAN'S PREFERENCE

A27.3 VETERAN'S PREFERENCE

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

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

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

APPROVED FOR LEGALITY:

/s/_____
Attorney for the City and
County of Denver

APPROVED AND ADOPTED:

/s/_____
Manager of Public Works

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

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

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RULES AND REGULATIONS
REGARDING
EQUAL EMPLOYMENT OPPORTUNITY

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

RULE I
DEFINITIONS

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

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RULE II
NOTICE OF HEARING

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

RULE III
HEARING

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

REGULATIONS

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

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

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

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

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

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

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

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

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

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

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

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

All amendments to the appendices shall be included by reference.

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

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

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

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

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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 f6r training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
2. The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap.
3. The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided, advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
4. Each contractor will comply with all provisions of Article III, Division 2, Chapter 28 of the Revised Municipal Code, and the rules, regulations, and relevant orders of the Manager and Director.
5. The contractor will furnish all information and reports required by Article III, Division 2, Chapter 28 of the Revised Municipal Code, and by rules, regulations and orders of the Manager and Director or pursuant thereto, and will permit access to his books, records, and accounts by the Manager, Director or their designee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
6. In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations or orders this contract may be cancelled, terminated., or suspended in whole or in part and the contractor may be declared ineligible for further City contracts in accordance with procedures authorized in Article III, Division 2, Chapter 28 of the Revised Municipal Code, or by rules, regulations, or order of the Manager.
7. The contractor will include Regulation 12 Paragraph 2 and the provisions of paragraphs (1) through (6) in every subcontract or purchase order unless, exempted by rules, regulations, or orders of the Manager issued pursuant to Article III, Division 2, Chapter 28 of the Revised Municipal Code, so that such provisions will be binding upon each subcontractor or suppliers. The contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance.

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

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

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

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

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APPENDIX F
BID CONDITIONS
AFFIRMATIVE ACTION REQUIREMENTS
EQUAL EMPLOYMENT OPPORTUNITY

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

NOTICE

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

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

EULOIS CLECKLEY
Manager of Public Works
City and County of Denver

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A. REQUIREMENTS --AN AFFIRM ATIVE ACTION PLAN:

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

1. GOALS AND TIMETABLES:

The goals and timetables for minority[1] 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 21.7% - 23.5% Until Further Notice	From January 1, 1982 to 6.9% Until Further Notice

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

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

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

[1] "Minority" is defined as including, Blacks, Spanish Surname Americans, Asian-Americans, and American Indians, and includes both men and Minority women.

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2. **SPECIFIC AFFIRMATIVE ACTION STEPS**:

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

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

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

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

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

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

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

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

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

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

B. **Obligations Applicable to Contractors**:

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

C. **General Requirements**

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

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

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EXHIBIT C

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

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 Excluded Parties under the definitions Section 7 for a general list of excluded parties. 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 III. These manuals are part of the Contract Documents.

DEN ROCIP III Insurance Manual
DEN ROCIP III Safety Manual
DEN ROCIP III Claims Guide

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

Contractor and subcontractors of any tier shall require all Excluded Parties, as defined in Section 7 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) must be emailed in pdf format to: contractadmininvoices@flydenver.com
- HARD COPIES of certificates and/or copies of insurance policies will not be accepted.
- ACORD FORM (or equivalent) must reference the DEN assigned Contract Number.

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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, and products and completed operations in minimum limits of $1,000,000 each occurrence, $2,000,000 products and completed operations aggregate and $2,000,000 annual aggregate.

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.

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, then a schedule of insured vehicles (including year, make, model and VIN number) must be submitted by the insurer with the Certificate of Insurance.

2.3.2.3 The policy must not contain an exclusion related to operations on airport premises.

2.3.2.4 If transporting waste, hazardous material, or regulated substances, Contractor shall carry a Broadened Pollution Endorsement and an MCS 90 endorsement on its policy.

2.3.2.5 If Contractor is an individual or represents that Contractor does not own any motor vehicles and Contractor's owners, officers, directors, and employees use their personal vehicles for business purposes, Personal Automobile Liability insurance coverage will be accepted provided it includes a business use endorsement.

2.3.2.6 If Contractor will be completing all services to DEN under this Agreement remotely this requirement will be 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 If Contractor is a sole proprietor, Workers' Compensation and Employer's Liability is exempt under the Colorado Workers' Compensation Act.

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.

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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 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.

2.3.6.1 Coverage shall include professional misconduct or lack of ordinary skill.

2.3.6.2 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.

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2.3.7 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:

2.3.7.1 Express written permission must be granted by DEN.
2.3.7.2 Express written permission must be granted by the Federal Aviation Administration (FAA).
2.3.7.3 Drone equipment must be properly registered with the FAA.
2.3.7.4 Drone operator(s) must be properly licensed by the FAA.
2.3.7.5 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.

2.3.8 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), 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, 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.

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 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

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in coverage and provide an updated Certificate of Insurance to DEN.

2.8 Additional Provisions

2.8.1 Deductibles, SIRS, or any other type of retention are the sole responsibility of the Contractor.

2.8.2 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.

2.8.3 A severability of interests or separation of insureds provision (no insured vs. insured exclusion) is included under any policy requiring Additional Insured status.

2.8.4 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.

2.8.5 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.

2.8.6 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.

2.8.7 Contractor shall advise DEN in the event any general aggregate or other aggregate limits are reduced below the required per occurrence limits. At their own expense, and where such general aggregate or other aggregate limits have been reduced below the required per occurrence limit, the Contractor will procure such per occurrence limits and furnish a new certificate of insurance showing such coverage is in force.

2.8.8 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 a person authorized by the insurer to bind coverage on its behalf and must be submitted to DEN at the time Contractor signed this Agreement.

2.8.9 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.

2.8.10 Certificate of Insurance and Related Endorsements: DEN's acceptance of a certificate of insurance or other proof of insurance that does not comply with all insurance requirements set forth in this Agreement shall not act as a waiver of Contractor's breach of this Agreement or of any of DEN's rights or remedies under this Agreement. DEN's acceptance of any submitted insurance certificate is subject to the approval of DEN Risk Management. All coverage requirements specified in the certificate 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 herein.

2.8.11 DEN shall have the right to verify or confirm, at any time, all coverage, information or representations, and the insured and its undersigned agent shall promptly and fully cooperate in any such audit DEN may elect to undertake including provision of certified copies of insurance policies upon request.

2.8.12 No material changes that negatively impact DEN or reductions in the coverage required herein shall be allowed without the review and written approval of 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)

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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 Excluded Parties (as defined in Section 7). 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

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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 Section 3.8 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)	$8,000,000
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

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below:

Coverage	Limit
Annual General Aggregate (Per Project and Reinstates Annually)	$200,000,000
Products/Completed Operations Aggregate (Per Project)	$200,000,000
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 $500,000,000 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,

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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. Lead 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 Arthur J. Gallagher RMS, Inc.
12444 Powerscourt Drive
St. Louis, MO 63131
Attn: Gallagher OCIP Group

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) must be emailed in pdf format to:
  contractadmininvoices@flydenver.com
  and heather_lawson@ajg.com
- HARD COPIES of certificates and/or copies of insurance policies will not be accepted.
- ACORD FORM (or equivalent) must reference the DEN assigned Contract Number.

3.9.3 Commercial General Liability – Off Site Only

Contractor shall maintain insurance coverage including bodily injury, property damage, personal injury, advertising injury, and products and completed operations for Contract operations not

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physically occurring within the Project Site in minimum limits of $1,000,000 each occurrence, $2,000,000 products and completed operations aggregate and $2,000,000 policy and annual aggregate.

3.9.3.1 Coverage shall include Contractual Liability covering liability assumed under this Agreement (including defense costs assumed under contract) within the scope of coverages provided.

3.9.4 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.

3.9.4.1 If operating vehicles unescorted airside at DEN, a $10,000,000 combined single limit each occurrence for bodily injury and property damage is required.

3.9.4.2 If Contractor does not have blanket coverage on all owned and operated vehicles, then a schedule of insured vehicles (including year, make, model and VIN number) must be submitted by the insurer with the Certificate of Insurance.

3.9.4.3 The policy must not contain an exclusion related to operations on airport premises.

3.9.4.4 If transporting waste, hazardous material, or regulated substances, Contractor shall carry a pollution coverage endorsement and an MCS 90 endorsement on its policy.

3.9.4.5 If Contractor is an individual or represents that Contractor does not own any motor vehicles and Contractor's owners, officers, directors, and employees use their personal vehicles for business purposes, Personal Automobile Liability insurance coverage will be accepted provided it includes a business use endorsement.

3.9.4.6 If Contractor will be completing all services to DEN under this Agreement remotely this requirement will be waived.

3.9.5 Workers' Compensation and Employer's Liability Insurance – Off Site Only

Coverage to protect Contractor/Subcontractor from and against all claims arising from performance of Work outside the Project Site under the Contract.

Contractor shall maintain the coverage as required by statute for performance of Work outside the Project Site under the Contract 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.

3.9.5.1 If Contractor is a sole proprietor, Workers' Compensation and Employer's Liability is exempt under the Colorado Workers'' Compensation Act.

3.9.6 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.

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.

3.9.7 Technology Errors and Omissions, Network Security, and Privacy Liability (Cyber): Contractor shall maintain a limit no less than $1,000,000 each claim and aggregate; $1,000,000

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each claim and aggregate for cyber extortion; and no less than $250,000 each claim for invoice manipulation and email spoofing for applicable services outlined in this Agreement.

3.9.7.1 Coverage shall include professional misconduct or lack of ordinary skill.

3.9.7.2 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.

3.9.8 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.

3.9.9 Reference to Project and/or Contract

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

3.9.10 Additional Insured

For all coverages required under this Agreement (excluding Workers' Compensation and Professional Liability), 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.

3.9.11 Waiver of Subrogation

For all coverages required under this Agreement, 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.

3.9.12 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 coverage from the requirements herein before the expiration date thereof.

3.9.12.1 Such notice shall reference the DEN assigned contract number related to this Agreement.

3.9.12.2 Said notice shall be sent thirty (30) days prior to such cancellation or non-renewal or reduction in coverage unless due to non-payment of premiums for which notice shall

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be sent ten (10) days prior.

3.9.12.3 If such written notice is unavailable from the insurer, and in any event, 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.

3.9.13 Additional Provisions

3.9.13.1 Deductibles, SIRS, or any other type of retention are the sole responsibility of the policyholder.

3.9.13.2 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.

3.9.13.3 A severability of interests or separation of insureds provision (no insured vs. insured exclusion) is included under any policy requiring Additional Insured status.

3.9.13.4 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.

3.9.13.5 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.

3.9.13.6 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.

3.9.13.7 Contractor shall advise DEN in the event any general aggregate or other aggregate limits are reduced below the required per occurrence limits. At their own expense, and where such general aggregate or other aggregate limits have been reduced below the required per occurrence limit, the Contractor will procure such per occurrence limits and furnish a new certificate of insurance showing such coverage is in force.

3.9.13.8 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 a person authorized by the insurer to bind coverage on its behalf and must be submitted to DEN at the time Contractor signed this Agreement.

3.9.13.9 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.

3.9.13.10 Certificate of Insurance and Related Endorsements: DEN's acceptance of a certificate of insurance or other proof of insurance that does not comply with all insurance requirements set forth in this Agreement shall not act as a waiver of Contractor's breach of this Agreement or of any of DEN's rights or remedies under this Agreement. DEN's acceptance of any submitted insurance certificate is subject to the approval of DEN Risk Management. All coverage requirements specified in the certificate shall be enforced unless waived or otherwise modified in writing by

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DEN Risk Management. Contractor is solely responsible for ensuring all formal policy endorsements are issued by their insurers to support the requirements herein.

3.9.13.11 DEN shall have the right to verify or confirm, at any time, all coverage, information or representations, and the insured and its undersigned agent shall promptly and fully cooperate in any such audit DEN may elect to undertake including provision of certified copies of insurance policies upon request.

3.9.13.12 No material changes that negatively impact DEN or reductions in the coverage required herein shall be allowed without the review and written approval of DEN Risk Management.

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

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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

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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

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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"

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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.
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 Lead 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 Lead 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.

- 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

- Contractors, subcontractors and subconsultants who do not work at a Project Site

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- 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

- Day labor employees (individuals working directly for the Contractor and not procured through a third party

  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.

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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

DENVER
THE MILE HIGH CITY

TO: All Users of the City and County of Denver Prevailing Wage Schedules
FROM: Ryland Feno, Classification and Compensation Technician II
DATE: January 13, 2020
SUBJECT: Latest Change to Prevailing Wage Schedules

The effective date for this publication will be **Friday, January 10, 2020** and applies to the City and County of Denver for **BUILDING 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. CO20200020
Superseded General Decision No. CO20190020
Modification No. 1
Publication Date: 01/10/2020
(6 pages)

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

Attachments as listed above.

***Career Service Board approved to adjust all Davis Bacon classifications under $13.00 to comply with the city's minimum wage. The effective date is August 15, 2019. See page 6 for reference.**

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"General Decision Number: CO20200020 01/10/2020

Superseded General Decision Number: CO20190020

State: Colorado

Construction Type: Building

County: Denver County in Colorado.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Under Executive Order (EO) 13658, an hourly minimum wage of $10.80 for calendar year 2020 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.80 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 calendar year 2020. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate,if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/03/2020
1	01/10/2020

ASBE0028-002 07/01/2019

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR - MECHANICAL (Duct, Pipe & Mechanical System Insulation)	$ 32.98	14.73

CARP0055-002 11/01/2019

	Rates	Fringes
CARPENTER (Drywall Hanging		

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Only).....$ 29.95 10.99

CARP1607-001 06/01/2019

	Rates	Fringes
MILLWRIGHT	$ 32.00	16.43

ELEC0068-012 06/01/2019

	Rates	Fringes
ELECTRICIAN (Includes Low Voltage Wiring)	$ 36.50	16.18

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* ELEV0025-001 01/01/2020

	Rates	Fringes
ELEVATOR MECHANIC	$ 46.53	34.765

FOOTNOTE:
a.Vacation: 6%/under 5 years based on regular hourly rate for all hours worked. 8%/over 5 years based on regular hourly rate for all hours worked.
b. PAID HOLIDAYS: New Year's Day; Memorial Day; Independence Day; Labor Day; Veterans' Day; Thanksgiving Day; the Friday after Thanksgiving Day; and Christmas Day.

ENGI0009-017 05/01/2018

	Rates	Fringes
POWER EQUIPMENT OPERATOR (Crane)		
141 tons and over	$ 31.07	10.70
50 tons and under	$ 28.40	10.70
51 to 90 tons	$ 28.57	10.70
91 to 140 tons	$ 29.55	10.70

IRON0024-009 01/01/2019

	Rates	Fringes
IRONWORKER, ORNAMENTAL	$ 29.85	11.42

IRON0024-010 01/01/2019

	Rates	Fringes
IRONWORKER, STRUCTURAL	$ 29.85	11.42

PAIN0079-006 08/01/2017

	Rates	Fringes

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PAINTER (Brush, Roller and Spray; Excludes Drywall Finishing/Taping)	$ 20.50	8.41

PAIN0079-007 08/01/2017

	Rates	Fringes
DRYWALL FINISHER/TAPER	$ 21.20	8.41

PAIN0419-001 07/01/2016

	Rates	Fringes
SOFT FLOOR LAYER (Vinyl and Carpet)	$ 20.00	10.83

PAIN0930-002 07/01/2019

	Rates	Fringes
GLAZIER	$ 31.92	10.49

PLUM0003-009 06/01/2018

	Rates	Fringes
PLUMBER (Excludes HVAC Duct, Pipe and Unit Installation)	$ 35.48	15.94

PLUM0208-008 06/01/2018

	Rates	Fringes
PIPEFITTER (Includes HVAC Pipe and Unit Installation; Excludes HVAC Duct Installation)	$ 37.55	14.95

SFCO0669-002 04/01/2017

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers)	$ 36.73	20.47

SHEE0009-004 07/01/2019

	Rates	Fringes
SHEET METAL WORKER (Includes HVAC Duct Installation; Excludes HVAC Pipe and Unit Installation)	$ 34.62	18.10

SUCO2013-006 07/31/2015

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	Rates	Fringes
BRICKLAYER	$ 21.96	0.00
CARPENTER (Acoustical Ceiling Installation Only)	$ 22.40	4.85
CARPENTER (Metal Stud Installation Only)	$ 17.68	0.00
CARPENTER, Excludes Acoustical Ceiling Installation, Drywall Hanging, and Metal Stud Installation	$ 21.09	6.31
CEMENT MASON/CONCRETE FINISHER	$ 20.09	7.03
LABORER: Common or General	$ 14.49	5.22
LABORER: Mason Tender - Brick	$ 15.99	0.00
LABORER: Mason Tender - Cement/Concrete	$ 16.00	0.00
LABORER: Pipelayer	$ 16.96	3.68
OPERATOR: Backhoe/Excavator/Trackhoe	$ 20.78	5.78
OPERATOR: Bobcat/Skid Steer/Skid Loader	$ 19.10	3.89
OPERATOR: Grader/Blade	$ 21.50	0.00
ROOFER	$ 16.56	0.00
TRUCK DRIVER: Dump Truck	$ 17.34	0.00
WATERPROOFER	$ 12.71	0.00

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

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Office of Human Resources
Supplemental Rates
(Specific to the Denver projects)
Revision Date: 08-21-2019

Classification		Base	Fringe
Boilermaker		$30.97	$21.45
Iron Worker, Reinforcing		$18.49	$3.87
Laborer: Concrete Saw		$13.89	-
Paper Hanger		$20.15	$6.91
Plasterer		$24.60	$12.11
Plaster Tender		$13.00	-
Power Equipment Operator	Concrete Mixer - Less than 1 yd	$23.67	$10.67
	Concrete Mixer - 1 yd and over	$23.82	$10.68
	Drillers	$23.97	$10.70
	Loader - up to and incl 6 cu yd	$23.67	$10.67
	Loaders - over 6 cu yd	$23.82	$10.68
	Mechanic	$18.48	-
	Motor Grader	$23.97	$10.70
	Oilers	$22.97	$10.70
	Roller	$23.67	$10.67
Tile Finisher		$20.87	$8.42
Tile Setter		$26.83	$8.48
Truck Driver	Flatbed	$19.14	$10.07
	Semi	$19.48	$10.11
Waterproofer		$13.00	$0.00

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

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EXHIBIT E

SPECIAL CONDITIONS

SC-1 CONSTRUCTION CONTRACT GENERAL CONDITIONS

The General Conditions constitute a part of the Contract Documents and 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 (which may be informally referred to as the "Yellow Book"). The General Conditions book is available for purchase at the following locations during the business hours stated, Monday through Friday, excluding holidays:

Office of the Cashier
Wellington E. Webb Municipal Office Building, 2nd Floor
201 West Colfax Avenue
Denver, Colorado, USA 80202
7:30 a.m. to 4:30 p.m.
The General Conditions are also available on the DEN Contract Procurement website and the City and County of Denver website at:

https://www.denvergov.org/content/denvergov/en/contract-administration/contractor-resources/general-contract-conditions.html
http://business.flydenver.com/bizops/commerceHub.asp

SC–2 DRAWINGS AND SPECIFICATIONS TO BE FURNISHED BY THE CITY

The City will provide the following contract documents to the Contractor in electronic format at no expense to the Contractor:

Construction Safety and Phasing Plan (CSPP) IFB
IFB Division 1 Specifications - General Requirements
IFB Division 2 Technical Specifications
Contract Drawings - Concourse A & C Pre-Conditioned Air Re-Life

Paper copies of the Contract 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.

SC-3 REVISIONS TO G.C. 201

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

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SC-4 CITY LINE OF AUTHORITY AND CONTACTS

In accordance with General Condition 214, the City's line of authority for administration of this Contract is:

Chief Executive Officer (CEO). Executive Office, 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 Operating Officer (EVP-COO) who reports to the CEO. Airport Infrastructure Management office, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

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

Senior Director of Airport Infrastructure Management (Director), reports to the SVP-AIM, Airport Infrastructure Management Division, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Project Manager, the City representative who has day to day administrative responsibility of this Contract, and who reports to the Senior Director-AIM. All notices, requests, pay applications (pursuant to G.C. 902), and other correspondence from the Contractor shall be sent to the assigned Project Manager unless otherwise provided in this Contract.

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

SC–5 CONTRACTOR PERFORMANCE; SUBCONTRACTING

With respect to General Condition 501, no more than 80% of the work may be subcontracted. If it is determined to be in the City's best interest, this percentage may be modified throughout the course of the project by the SVP-AIM.

SC–6 COOPERATION WITH OTHERS

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

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

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Contract No.	Description
201733063	Concourse Expansion
201631723	Concourse Expansion
201951349	Boiler 1, 3, 4
TBD	Pump Room Replacement
TBD	CUP Chiller Replacement
TBD	Passenger Loading Bridge
TBD	New Pre Conditioned Air Units at the Passenger Loading Bridges (installation)

SC–7 PROSECUTION AND COMPLETION OF THE WORK:

The Work to be performed under the Contract is described in the Technical Specifications and Contract Drawings. The Contractor shall complete the Work within five hundred forty-eight (548) consecutive calendar days from Notice to Proceed.

The Work to be performed under the Contract is divided into the following 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 below:

Milestone	Date of Completion (or, days from NTP)
1. CCA PC Air Chillers substantial completion	300 calendar days from Notice to Proceed
2. CCC PC Air Chillers substantial completion	365 calendar days from Notice to Proceed
3. CCA Heat Exchangers substantial completion	548 calendar days from Notice to Proceed
4. CCC Heat Exchangers substantial completion	548 calendar days from Notice to Proceed

SC–8 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 per phase (Items 1-4) until each partial substantial completion is achieved. Additionally, if the Contractor fails to substantially complete the Work described in a project Milestone within the time specified in SC-7 PROSECUTION AND COMPLETION OF THE WORK, the Contractor shall be liable to the City for liquidated damages at the following rates per day until such substantial completion is achieved:

Failure to substantially complete the Work described in Milestone:

	Amount per day
1. CCA PC Air Chillers Sub complete	$3,500.00
2. CCC PC Air Chillers Sub complete	$3,500.00
3. CCA Heat Exchangers sub complete	$1,000.00
4. CCC Heat Exchangers sub complete	$1,000.00

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

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SC–9 FACILITY SECURITY AND PERSONNEL ACCESS

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

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

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

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

The construction of all the Project / Task Items that involve the breaching of any airport perimeter security boundary or continued access to restricted access rooms or areas will require the posting of authorized contract security personnel to maintain required security controls. The Contractor's **Guarantee Maximum Price / Total Contract BID Amount / Task Order Proposal** 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

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RESULT IF AIRPORT PERIMETER SECURITY REQUIREMENTS ARE NOT STRICTLY FOLLOWED. THE REQUIREMENT TO PROVIDE ONE HUNDRED PERCENT (100%) CONTROL AND SUPERVISION OF BREACHES IN THE AIRPORT'S PERIMETER SECURITY BOUNDARY IS ABSOLUTE. AT NO TIME, DURING WORK AND NON-WORK HOURS SHALL ANY BREACHES IN THE AIRPORT'S SECURITY PERIMETER BE UNSUPERVISED AND / OR UNSECURED.

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

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

HSS
900 S. Broadway, Suite 100
Denver, Colorado 80209

DEN Contact: Glenn Spies
(303) 342-4323

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

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

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

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

SC-10 CONSTRUCTION ACCESS

The work site(s) is(are) located at Concourse A and Concourse C tunnels. The Contractor shall have access to the work site via Gate 5 and Concourse Apron Entrances.

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.

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

SC–11 VEHICLE PERMITTING

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

SC–12 VENDORS AND SUPPLIERS

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

SC–13 COMMUNICATION DEVICES

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

SC–14 USE, POSSESSION OR SALE OF ALCOHOL OR DRUGS

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

SC-15 ATTORNEY'S FEES

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

SC–16 INSURANCE REQUIREMENTS

In accordance with the provisions of Title 16 of the General Conditions, the minimum insurance requirements for this contract are set forth in the ROCIP III Insurance Manual, linked under the insurance requirements for this Contract. 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

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

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

The City and County of Denver in no way warrants that the minimum limits contained herein are sufficient to protect the Contractor from liabilities that might arise out of the performance of the work under this Contract by the Contractor, his agents, representatives, employees or sub- contractors. The Contractor shall assess its own risks as it deems appropriate and/or prudent, maintain higher limits and/or broader coverages. The Contractor is not relieved of any liability or other obligations assumed or pursuant to the Contract by reason of its failure to obtain or maintain insurance in sufficient amounts, duration or types.

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

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

All certificates required by this Contract shall be sent directly to Denver International Airport, Business Management Services, Airport Office Building, Room 8810, 8500 Pena Boulevard, Denver, Colorado 80249. The City project/Contract number and project description shall be noted on the certificate of insurance. The City reserves the right to require complete, certified copies of all insurance policies required by this Contract at any time.

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

SC–17 SUBCONTRACTOR RELEASES

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

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SC–18 ADDITIONAL AFFIRMATIVE ACTION REQUIREMENTS, FEDERAL PROVISIONS

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

SC-19 ESTIMATED QUANTITIES OF UNIT PRICED ITEMS

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

SC-20 REVISIONS TO G.C. 1102

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

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

SC-21 LISTING OF ACCEPTABLE MANUFACTURERS

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

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

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

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

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

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

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

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

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

SC-24 PAYMENTS TO CONTRACTORS

The Contractor recognizes and agrees that applications for payment shall be submitted using the Textura® Construction Payment Management System (CPM 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 CPM 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 CPM 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 CPM 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:

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Agency/Firm
DEN Division CA
DEN Division PM
DEN Division Director
DEN Contract Svcs 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 completed Partial or Final Claim Release Form, as appropriate, from EACH subcontractor and supplier, **AND** the Contractor's Certification of Payment Form.

SC-25 DISPOSAL OF NON-HAZARDOUS WASTE AT DADS

In accordance with the Landfill Contract made between the City and Waste Management of Colorado, Inc., bidders will be required to haul dedicated loads (non-hazardous entire loads of waste) to the Denver-Arapahoe Disposal Site ("**DADS**") for disposal. DADS is located at Highway 30 and Hampden Avenue in Arapahoe County, Colorado. The City will pay all fees associated with such disposal but the bidder shall be responsible for the costs of transporting the loads. Non-hazardous waste is defined as those substances and materials not defined or classified as hazardous by the Colorado Hazardous Waste Commission pursuant to C.R.S. § 25-15-207, as amended from time to time, and includes construction debris, soil and asbestos. Bidders shall not use Gun Club Road between I-70 and Mississippi Avenue as a means of access to DADS.

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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

Statement

The City and County of Denver does not warrant or represent the accuracy or timeliness of the information contained in this page or any of its constituent pages and the information presented is for instructional purposes and illustration only and is not intended to be specific advice, legal or otherwise. The City has made every effort to provide accurate up-to-date information, however this database is dynamic and errors can occur. The City and County of Denver shall not be held responsible for errors or omissions nor be liable for any special consequential or exemplary damages resulting, in whole or in part, from any viewer(s)' uses of, or in reliance upon, this material.

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EXHIBIT G

Bond No. 6355554, 106873435, 82590111

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned PCL Construction Services, Inc., a corporation organized under the laws of the State of Colorado, hereinafter referred to as the "Contractor" and Fidelity and Deposit Company of Maryland, Travelers Casualty and Surety Company of America, Federal Insurance Company, a corporation organized under the laws of the State of IL, CT, IN, 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 Seventeen Million, One Hundred Thousand and 00/100 Dollars ($17,100,000.00), 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 201951778, Concourse A & C Pre-Conditioned Air Re-Life, 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)

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IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this 10th day of June, 2020.

PCL Construction Services, Inc.
CONTRACTOR

By:_____
~~President~~ District Manager

Fidelity and Deposit Company of Maryland
Travelers Casualty and Surety Company of America
Federal Insurance Company
SURETY

By:_____
Attorney-in-Fact
Sandra M. Winsted

(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

Signatures by CAO and the Mayor will be provided later and shall be fully incorporated herein.

By:_____
MAYOR

By:_____
Chief Executive Officer
Denver International Airport

APPROVED AS TO FORM:

KRISTIN M. BRONSON, Attorney for the City and County of Denver

By:_____
Assistant City Attorney

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

KNOW ALL MEN BY THESE PRESENTS: That the ZURICH AMERICAN INSURANCE COMPANY, a corporation of the State of New York, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, a corporation of the State of Illinois, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND a corporation of the State of Illinois (herein collectively called the "Companies"), by **Robert D. Murray, Vice President**, in pursuance of authority granted by Article V, Section 8, of the By-Laws of said Companies, which are set forth on the reverse side hereof and are hereby certified to be in full force and effect on the date hereof, do hereby nominate, constitute, and appoint **Sandra M. WINSTED, Diane M. O'LEARY, Susan A. WELSH, Judith A. LUCKY-EFTIMOV, James B. MCTAGGART, Debra J. DOYLE, Sandra M. NOWAK, Jessica B. DEMPSEY, Christina L. SANDOVAL, Kristin L HANNIGAN and Samantha CHIERICI, all of Chicago, Illinois,** EACH, its true and lawful agent and Attorney-in-Fact, to make, execute, seal and deliver, for, and on its behalf as surety, and as its act and deed: any and all bonds and undertakings, and the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Companies, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the ZURICH AMERICAN INSURANCE COMPANY at its office in New York, New York., the regularly elected officers of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at its office in Owings Mills, Maryland, and the regularly elected officers of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at its office in Owings Mills, Maryland, in their own proper persons.

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

IN WITNESS WHEREOF, the said Vice-President has hereunto subscribed his/her names and affixed the Corporate Seals of the said **ZURICH AMERICAN INSURANCE COMPANY, COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and FIDELITY AND DEPOSIT COMPANY OF MARYLAND**, this 8th day of April, A.D. 2020.

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

By: Robert D. Murray
Vice President

By: Dawn E. Brown
Secretary

State of Maryland
County of Baltimore

On this 8th day of April, A.D. 2020, before the subscriber, a Notary Public of the State of Maryland, duly commissioned and qualified, **Robert D. Murray, Vice President and Dawn E. Brown, Secretary** of the Companies, to me personally known to be the individuals and officers described in and who executed the preceding instrument, and acknowledged the execution of same, and being by me duly sworn, deposeth and saith, that he/she is the said officer of the Company aforesaid, and that the seals affixed to the preceding instrument are the Corporate Seals of said Companies, and that the said Corporate Seals and the signature as such officer were duly affixed and subscribed to the said instrument by the authority and direction of the said Corporations.

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

Constance A. Dunn, Notary Public
My Commission Expires: July 9, 2023

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TRAVELERS

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

POWER OF ATTORNEY

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

IN WITNESS WHEREOF, the Companies have caused this instrument to be signed, and their corporate seals to be hereto affixed, this **3rd** day of **February**, **2017.**

State of Connecticut

City of Hartford ss.

By: _____
Robert L. Raney, Senior Vice President

On this the **3rd** day of **February**, **2017**, before me personally appeared **Robert L. Raney**, who acknowledged himself to be the Senior Vice President of Travelers Casualty and Surety Company of America, Travelers Casualty and Surety Company, and St. Paul Fire and Marine Insurance Company, and that he, as such, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer.

In Witness Whereof, I hereunto set my hand and official seal.

My Commission expires the **30th** day of **June**, **2021**

Marie C. Tetreault
Marie C. Tetreault, Notary Public

This Power of Attorney is granted under and by the authority of the following resolutions adopted by the Boards of Directors of Travelers Casualty and Surety Company of America, Travelers Casualty and Surety Company, and St. Paul Fire and Marine Insurance Company, which resolutions are now in full force and effect, reading as follows:

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

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

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

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

I, **Kevin E. Hughes**, the undersigned, Assistant Secretary of Travelers Casualty and Surety Company of America, Travelers Casualty and Surety Company, and St. Paul Fire and Marine Insurance Company, do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which remains in full force and effect.

Dated this 10 day of June 2020

Kevin E. Hughes, Assistant Secretary

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

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CHUBB

Power of Attorney

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

Know All by These Presents, that **FEDERAL INSURANCE COMPANY**, an Indiana corporation, **VIGILANT INSURANCE COMPANY**, a New York corporation, **PACIFIC INDEMNITY COMPANY**, a Wisconsin corporation, **WESTCHESTER FIRE INSURANCE COMPANY** and **ACE AMERICAN INSURANCE COMPANY** corporations of the Commonwealth of Pennsylvania, do each hereby constitute and appoint Samantha Chierici, Jessica B. Dempsey, Debra J. Doyle, Derek J. Elston, Kristin L Hannigan, Jennifer L. Jakaitis, Andrew Marks, James B. McTaggart, Judith A. Lucky-Eftimov, Sandra M. Nowak, Diane M. O'Leary, Nicholas Pantazis, Christina L. Sandoval, Bartlomiej Siepierski, Christopher P. Troha, Aerie Walton, Susan A. Welsh and Sandra M. Winsted of Chicago, Illinois ----------

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

In Witness Whereof, said **FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY** and **ACE AMERICAN INSURANCE COMPANY** have each executed and attested these presents and affixed their corporate seals on this **16th** day of **January, 2020.**

Dawn M. Chloros, Assistant Secretary

Stephen M. Haney, Vice President

STATE OF NEW JERSEY
County of Hunterdon ss.

On this **16th** day of **January, 2020** before me, a Notary Public of New Jersey, personally came Dawn M. Chloros and Stephen M. Haney, to me known to be Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY, the companies which executed the foregoing Power of Attorney, and the said Dawn M. Chloros and Stephen M. Haney, being by me duly sworn, severally and each for herself and himself did depose and say that they are Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY and know the corporate seals thereof, that the seals affixed to the foregoing Power of Attorney are such corporate seals and were thereto affixed by authority of said Companies; and that their signatures as such officers were duly affixed and subscribed by like authority.

Notarial Seal

KATHERINE J. ADELAAR
NOTARY PUBLIC OF NEW JERSEY
No. 2316685
Commission Expires July 16, 2024

Notary Public

CERTIFICATION

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

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

(1) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise.

(2) Each duly appointed attorney-in-fact of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise, to the extent that such action is authorized by the grant of powers provided for in such person's written appointment as such attorney-in-fact.

(3) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to appoint in writing any person the attorney-in-fact of the Company with full power and authority to execute, for and on behalf of the Company, under the seal of the Company or otherwise, such Written Commitments of the Company as may be specified in such written appointment, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.

(4) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to delegate in writing to any other officer of the Company the authority to execute, for and on behalf of the Company, under the Company's seal or otherwise, such Written Commitments of the Company as are specified in such written delegation, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.

(5) The signature of any officer or other person executing any Written Commitment or appointment or delegation pursuant to this Resolution, and the seal of the Company, may be affixed by facsimile on such Written Commitment or written appointment or delegation.

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

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

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

Given under my hand and seals of said Companies at Whitehouse Station, NJ, this 6/10/2020

Dawn M. Chloros, Assistant Secretary

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

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EXHIBIT H

Bond No. 6355554, 106873435, 82590111

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned PCL Construction Services, Inc., a corporation organized under the laws of the State of Colorado, hereinafter referred to as the "Contractor" and Fidelity and Deposit Company of Maryland, Travelers Casualty and Surety Company of America, Federal Insurance Company, a corporation organized under the laws of the State of IL, CT, IN, 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 Seventeen Million, One Hundred Thousand and 00/100 Dollars ($17,100,000.00), 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 201951778, Concourse A & C Pre-Conditioned Air Re-Life, 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]

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IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this 10th day of June, 2020.

PCL Construction Services, Inc.
CONTRACTOR

By: _____
~~President~~ District Manager

Fidelity and Deposit Company of Maryland
Travelers Casualty and Surety Company of America
Federal Insurance Company
SURETY

By: _____
Attorney-in-Fact
Sandra M. Winsted

(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

Signatures by CAO and the Mayor will be provided later and shall be fully incorporated herein.

By: _____
MAYOR

By: _____
Chief Executive Officer
Denver International Airport

APPROVED AS TO FORM:

KRISTIN M. BRONSON, Attorney for the City and County of Denver

By: _____
Assistant City Attorney

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

KNOW ALL MEN BY THESE PRESENTS: That the ZURICH AMERICAN INSURANCE COMPANY, a corporation of the State of New York, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, a corporation of the State of Illinois, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND a corporation of the State of Illinois (herein collectively called the "Companies"), by **Robert D. Murray, Vice President**, in pursuance of authority granted by Article V, Section 8, of the By-Laws of said Companies, which are set forth on the reverse side hereof and are hereby certified to be in full force and effect on the date hereof, do hereby nominate, constitute, and appoint **Sandra M. WINSTED, Diane M. O'LEARY, Susan A. WELSH, Judith A. LUCKY-EFTIMOV, James B. MCTAGGART, Debra J. DOYLE, Sandra M. NOWAK, Jessica B. DEMPSEY, Christina L. SANDOVAL, Kristin L HANNIGAN and Samantha CHIERICI, all of Chicago, Illinois,** EACH, its true and lawful agent and Attorney-in-Fact, to make, execute, seal and deliver, for, and on its behalf as surety, and as its act and deed: any and all bonds and undertakings, and the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Companies, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the ZURICH AMERICAN INSURANCE COMPANY at its office in New York, New York., the regularly elected officers of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at its office in Owings Mills, Maryland, and the regularly elected officers of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at its office in Owings Mills, Maryland, in their own proper persons.

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

IN WITNESS WHEREOF, the said Vice-President has hereunto subscribed his/her names and affixed the Corporate Seals of the said **ZURICH AMERICAN INSURANCE COMPANY, COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and FIDELITY AND DEPOSIT COMPANY OF MARYLAND**, this 8th day of April, A.D. 2020.

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

By: Robert D. Murray
Vice President

By: Dawn E. Brown
Secretary

State of Maryland
County of Baltimore

On this 8th day of April, A.D. 2020, before the subscriber, a Notary Public of the State of Maryland, duly commissioned and qualified, **Robert D. Murray, Vice President and Dawn E. Brown, Secretary** of the Companies, to me personally known to be the individuals and officers described in and who executed the preceding instrument, and acknowledged the execution of same, and being by me duly sworn, deposeth and saith, that he/she is the said officer of the Company aforesaid, and that the seals affixed to the preceding instrument are the Corporate Seals of said Companies, and that the said Corporate Seals and the signature as such officer were duly affixed and subscribed to the said instrument by the authority and direction of the said Corporations.

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

Constance A. Dunn, Notary Public
My Commission Expires: July 9, 2023

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TRAVELERS

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

POWER OF ATTORNEY

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

IN WITNESS WHEREOF, the Companies have caused this instrument to be signed, and their corporate seals to be hereto affixed, this **3rd** day of **February**, **2017.**

State of Connecticut

City of Hartford ss.

By: _____
Robert L. Raney, Senior Vice President

On this the **3rd** day of **February**, **2017**, before me personally appeared **Robert L. Raney**, who acknowledged himself to be the Senior Vice President of Travelers Casualty and Surety Company of America, Travelers Casualty and Surety Company, and St. Paul Fire and Marine Insurance Company, and that he, as such, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer.

In Witness Whereof, I hereunto set my hand and official seal.

My Commission expires the **30th** day of **June**, **2021**

Marie C. Tetreault
Marie C. Tetreault, Notary Public

This Power of Attorney is granted under and by the authority of the following resolutions adopted by the Boards of Directors of Travelers Casualty and Surety Company of America, Travelers Casualty and Surety Company, and St. Paul Fire and Marine Insurance Company, which resolutions are now in full force and effect, reading as follows:

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

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

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

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

I, **Kevin E. Hughes**, the undersigned, Assistant Secretary of Travelers Casualty and Surety Company of America, Travelers Casualty and Surety Company, and St. Paul Fire and Marine Insurance Company, do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which remains in full force and effect.

Dated this 10 day of June 2020

Kevin E. Hughes, Assistant Secretary

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

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CHUBB

Power of Attorney

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

Know All by These Presents, that **FEDERAL INSURANCE COMPANY**, an Indiana corporation, **VIGILANT INSURANCE COMPANY**, a New York corporation, **PACIFIC INDEMNITY COMPANY**, a Wisconsin corporation, **WESTCHESTER FIRE INSURANCE COMPANY** and **ACE AMERICAN INSURANCE COMPANY** corporations of the Commonwealth of Pennsylvania, do each hereby constitute and appoint Samantha Chierici, Jessica B. Dempsey, Debra J. Doyle, Derek J. Elston, Kristin L Hannigan, Jennifer L. Jakaitis, Andrew Marks, James B. McTaggart, Judith A. Lucky-Eftimov, Sandra M. Nowak, Diane M. O'Leary, Nicholas Pantazis, Christina L. Sandoval, Bartlomiej Siepierski, Christopher P. Troha, Aerie Walton, Susan A. Welsh and Sandra M. Winsted of Chicago, Illinois ----------

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

In Witness Whereof, said **FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY** and **ACE AMERICAN INSURANCE COMPANY** have each executed and attested these presents and affixed their corporate seals on this **16th** day of **January, 2020.**

Dawn M. Chloros, Assistant Secretary

Stephen M. Haney, Vice President

STATE OF NEW JERSEY
County of Hunterdon ss.

On this **16th** day of **January, 2020** before me, a Notary Public of New Jersey, personally came Dawn M. Chloros and Stephen M. Haney, to me known to be Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY, the companies which executed the foregoing Power of Attorney, and the said Dawn M. Chloros and Stephen M. Haney, being by me duly sworn, severally and each for herself and himself did depose and say that they are Assistant Secretary and Vice President, respectively, of FEDERAL INSURANCE COMPANY, VIGILANT INSURANCE COMPANY, PACIFIC INDEMNITY COMPANY, WESTCHESTER FIRE INSURANCE COMPANY and ACE AMERICAN INSURANCE COMPANY and know the corporate seals thereof, that the seals affixed to the foregoing Power of Attorney are such corporate seals and were thereto affixed by authority of said Companies; and that their signatures as such officers were duly affixed and subscribed by like authority.

Notarial Seal

KATHERINE J. ADELAAR
NOTARY PUBLIC OF NEW JERSEY
No. 2316685
Commission Expires July 16, 2024

Notary Public

CERTIFICATION

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

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

(1) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise.

(2) Each duly appointed attorney-in-fact of the Company is hereby authorized to execute any Written Commitment for and on behalf of the Company, under the seal of the Company or otherwise, to the extent that such action is authorized by the grant of powers provided for in such person's written appointment as such attorney-in-fact.

(3) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to appoint in writing any person the attorney-in-fact of the Company with full power and authority to execute, for and on behalf of the Company, under the seal of the Company or otherwise, such Written Commitments of the Company as may be specified in such written appointment, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.

(4) Each of the Chairman, the President and the Vice Presidents of the Company is hereby authorized, for and on behalf of the Company, to delegate in writing to any other officer of the Company the authority to execute, for and on behalf of the Company, under the Company's seal or otherwise, such Written Commitments of the Company as are specified in such written delegation, which specification may be by general type or class of Written Commitments or by specification of one or more particular Written Commitments.

(5) The signature of any officer or other person executing any Written Commitment or appointment or delegation pursuant to this Resolution, and the seal of the Company, may be affixed by facsimile on such Written Commitment or written appointment or delegation.

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

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

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

Given under my hand and seals of said Companies at Whitehouse Station, NJ, this 6/10/2020

Dawn M. Chloros, Assistant Secretary

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

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EXHIBIT I

DESIGN CONTRACT NO. : 201732333 T014

CONFORMED SET

CCA & CCC
PCA PLANTS RE-LIFE

SPECIFICATIONS
VOLUME 1

21 MAY 2020

Prepared By
Wong Strauch Architects, P.C.
820 Santa Fe Drive
Denver, Colorado 80204

CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION

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DIVISION 1 – GENERAL REQUIREMENTS

011100 Summary of Work – Refer to Division 1 Specification
011400 Work Sequence and Constraints
011430 Vehicle and Equipment Permitting
011810 Utilities Interface
012025 Measurement for Payment
012300 Alternatives
012510 Substitutions
012910 Schedule of Values
013100 Project Management and Coordination
013119 Project Meetings
013210 Schedule
013223 Construction Layout, As-Built and Quantity Surveys
013223.11 Construction Layout and As-Built Surveys
013223.15 Survey Information
013223.19 Quantity Surveys
013233 Photographic Documentation
013300 Submittal Procedures
013325 Shop and Working Drawings, Product Data and Samples
013510 Construction Safety
013516 Alteration project Procedures
013520 Construction Safety – Airside
014100 Regulatory Requirements
014210 Referenced Material
014220 Abbreviations and Symbols
014225 Referenced Standards
014230 Definitions and Conventions
014310 DEN Quality Assurance
014510 Contractor Quality Assurance
014525 Material Testing Agency
014545 Special Inspection Agency and Owner Testing Agency(s)
015050 Mobilization
015210 Temporary Facilities
015215 Field Offices
015525 Traffic Control
015719 Temporary Environmental Controls
015810 Temporary Signage
016000 Product Requirements
016610 Storage and Protection
017300 Execution
017330 Cutting and Patching
017419 Construction Waste Management and Disposal
017420 Cleaning
017515 System Startup, Testing and Training
017720 Contract Closeout
017825 Operation and Maintenance Data
017835 Warranties and Bonds
017840 Contract Record Documents
017900 Demonstration and Training
019113 General Commissioning Requirements

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019990 Standard Forms

DIVISION 2 – EXISTING CONDITIONS
024119 Selective Demolition

DIVISION 3 – CONCRETE
033000 Cast-In-Place Concrete

DIVISION 5 – METALS
050510 Welding
051200 Structural Steel Framing
053100 Steel Decking
054000 Cold-Formed Metal Framing
055000 Metal Fabrications
055113 Metal Pan Stairs
055213 Pipe and Tube Railings

DIVISION 7 – THERMAL AND MOISTURE PROTECTION
072500 Weather Barriers
079200 Joint Sealants

DIVISION 8 – OPENINGS
081113 Hollow Metal Doors and Frames
083323 Overhead Coiling Doors
087100 Hardware
089000 Louvers and Vents

DIVISION 9 – FINISHES
092216 Non-Structural Metal Framing
092900 Gypsum Board
098433 Sound-Absorbing Wall/Ceiling Units
099123 Interior Painting
099600 High Performance Paint

DIVISION 31 – EARTHWORK
316329.10 Drilled Micro-Piles

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SECTION 011100 - SUMMARY OF WORK

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 AND DESCRIPTION

The Work specified in this contract consists of: Overall this project consists of removal and replacement of the existing preconditioned air plants In the basement of Concourse A and Concourse C at Denver International Airport. To facilitate this replacement, the existing interior perimeter wall will be demolished, the existing slab on grade will be demolished, a new structural concrete floor will be installed and a new interior perimeter wall installed. The construction will be carried out in a series of phases (Refer to Phasing Plans A003 of each package). All existing Mechanical Equipment will remain in place until cut over to new equipment, after which the existing equipment will be removed. Electrical scope of work involves providing power to the new mechanical equipment and then removal of existing power serving existing equipment (cut over). New LED lighting will be installed and replacement of Fire Alarms. At Gates C28 and C29 existing DX PC Air Units will be removed and replaced with hydronic units connected to the main PC Air piping and electrical power. Incidental work involves construction and demolition of an existing portion enclosing the construction area, installation of stairs, ramps, doors, hardware and railings as indicated/required and finishes as indicated. The existing Fire Protection System will remain in place and not be modified.

A. 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.

B. 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.

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4. The Contractor shall not proceed on any change notice work until a change order is issued.

C. 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.

D. Guaranteed Maximum Price (GMP): For Contracts assigned as GMP the Contractor shall follow the Special Conditions issued for the Contract.

E. 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.

F. 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 BIM group and the coordination meeting instructions.

G. 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

H. 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

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Contractor Quality Control at any time. Testing and Inspections for structural elements[reinforced concrete, steel, , fire protection, 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.

I. 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.

J. 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 standards and the requirements of the Contract Documents.

1.3 WORK BY OTHERS AND FUTURE WORK

A. Refer to Title 7 – Cooperation, Coordination and Rate of Progress of the General Contract Conditions, 2011 Edition

1.4 SITE CONDITIONS

A. Refer to Title 14 – Site Conditions of the General Contract Conditions, 2011 Edition

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 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 limited to, supplementary lighting of work

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areas, availability of medical facilities, security precautions, and noise limitations.

3.2 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.

3.3 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

4.1 METHOD OF MEASUREMENT

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

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PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section.

END OF SECTION **011100**

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SECTION 011400 - WORK SEQUENCE AND CONSTRAINTS

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 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.

1.3 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".

1.4 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

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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.

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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).

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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.

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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

1.5 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

3.1 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

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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.

3.2 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

4.1 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.

END OF SECTION 011400

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SECTION 011430 - VEHICLE AND EQUIPMENT PERMITTING

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. 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 for vehicles 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 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.
2. All Work shall be accomplished in accordance with the most current TSA Security Directives applicable to DEN, except as modified herein.
3. Access to the runways, taxiways, and aprons shall be gained by the Contractor 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 a route assigned by Airport Security. 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

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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. For additional information regarding permitting, the Contractor must contact DEN Security.

E. Equipment Permitting

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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".

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 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. Vehicle permit: DEN Engineering Group or DEN Airport Security.
2. Equipment and vehicle emissions permit. DEN Engineering or DEN Maintenance Group.

3.2 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

4.1 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.

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END OF SECTION **011430**

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SECTION 011810 - UTILITIES INTERFACE

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. Various utilities are located within the limits of work in the Project area. The owners of these utilities hereinafter noted may require that the Contractor is to work around their existing facilities until such alterations, relocation, or abandonment have been completed. All known existing utilities are shown; however, the Contractor shall verify and satisfy himself that there are no other existing utilities that may not be shown.

B. The owners of known utilities within the project area and corresponding representatives 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. Denver Water Department
8. Inland Technologies
9. Fuel System (ASI)
10. Premise Wiring System- DEN IT Section
11. FAA Duct Bank
12. Oil/Gas Wells
13. DEN Electrical Department
14. Fire Alarm System
15. 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. 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

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previous construction contractors that were the basis for determining utility coordinates. The Contractor is responsible for confirming the accuracy of the provided coordinates.

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.

1.3 REFERENCE DOCUMENTS

A. Section 312323.33 "Flowable Backfill (Controlled Low-Strength Material)"

1.4 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.

1.5 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.

1.6 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.

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PART 2 - PRODUCTS

2.1 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

3.1 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

4.1 METHOD OF MEASUREMENT

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

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PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section.

END OF SECTION **011810**

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SECTION 012025 - MEASUREMENT FOR PAYMENT

Per the DEN Technical Specification Committee, this section is deleted from the DEN Technical Specification Library.

This Section has no Section Text. Measurement and Payment information is detailed in each individual section.

PART 1 - GENERAL (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION **012025**

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SECTION 012300 - ALTERNATES

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. Section includes administrative and procedural requirements for alternates.

1.3 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.

1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Prior to the Contractor signing the Contract, the Owner will notify each party involved, in writing, of the status of each alternate, indicating if alternates have been accepted, rejected, or deferred for later consideration. The owner will also include a complete description of negotiated revisions to alternates.

C. Execute accepted alternates under the same conditions as other Work of the Contract.

D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to

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achieve the Work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

A. Alternate No. <**Insert number**>: <**Insert title of alternate**>.

1. Base Bid: <**Insert brief description of base-bid requirement**> [**as indicated on Sheet** <**Insert title of sheet**>] [**and**] [**as specified in Section** <**Insert Section number**> **"**<**Insert Section title**>**."**]
2. Alternate: <**Insert brief description of alternate requirement**> [**as indicated on Sheet** <**Insert title of sheet**>] [**and**] [**as specified in Section** <**Insert Section number**> **"**<**Insert Section title**>**."**]

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.

END OF SECTION **012300**

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SECTION 012510 - SUBSTITUTIONS

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. 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 the Scope of Work, 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.

1.3 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"

1.4 QUALITY CONTROL

1. The substitution shall provide as a minimum, the same performance as specified.

1.5 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.

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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

3.1 SUBSTITUTION PROCESS

A. Provide the information as required on Form CM-09.

3.2 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 Sr. 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.

3.3 CONDITIONS

A. As a condition for submitting a Request for Substitution the Contractor waives all rights to claim for extra cost or change in Contract time other than those outlined in the request and approved by the Deputy Manager of Aviation. 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."

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C. The statement shall be signed and dated by the Contractor's Superintendent.

D. Replacement of Substitution Found to be Not Equal:. The Contractor shall be responsible for all aspects and conditions of the substitution that are not clearly identified in the substitution submittal, and shall be liable for the appearance, function, performance or other aspects of the substitution that are found not to be equal to the originally specified item.

1. The Contractor shall incur all labor and costs associated with replacement of any substitution that is found to be not equal to the originally specified item or process and rejected by the DEN Project Manager.
2. The replacement of any rejected substitution shall either be with the originally specified item or process, or a substitution approved by the DEN Project Manager

PART 4 - MEASUREMENT

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.

END OF SECTION **012510**

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SECTION 012910 - SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 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.

1.2 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 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. 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.

1.3 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

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1.4 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.

1.5 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

3.1 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.

3.2 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.

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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.

3.3 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.

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3.4 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

4.1 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.

END OF SECTION **012910**

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SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

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. 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 013210 "Schedule” for preparing and submitting Contractor's Construction Schedule.
4. Section 013223 "Construction Layout, As-built and Quantity Surveys” for coordinating, survey activities and survey related record documents.
5. Section 013300 “Submittal Procedures. “
6. Section 013325 “Shop and Working Drawings, Product Data and Samples".
7. Section 017720 "Contract Closeout" for coordinating closeout of the Contract.
8. Section 017419 "Construction Waste Management and Recycling".
9. DEN Building Information Modeling (BIM) Design Standards Manual (DSM)

1.3 DEFINITIONS

A. RFI: Request from the DEN Contractor DEN Project Manager seeking information required by or clarifications of the Contract Documents.

1.4 SUBMITTALS - SUBCONTRACTORS ACCEPTANCE CERTIFICATION AND

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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.

1.5 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:

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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."

1.6 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

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e. Most current version of Revit, as per DEN requirements.

1.7 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,

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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.

9. 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.

C. 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.

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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”

1.8 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

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subcontractor contact information
2. Pertaining shop drawings
3. Operational Manuals and safety information, ~~M~~SDS 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

1.9 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.

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7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

E. DEN Project Manager will review each RFI, determine action required, and respond. RFIs received by DEN Project Manager after 1:00 p.m. will be considered as received the following working day. Direct responses by any entity other than DEN Project Manager shall not be binding to the City and County of Denver. E-mails, and verbal conversations must be followed by an official RFI or proper contractual vehicle before it is considered for any additional compensation or time impact to the project terms and conditions.

1. The following Contractor-generated RFIs will be returned without action:

    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for approval of Contractor's means and methods.
    d. Requests for coordination information already indicated in the Contract Documents.
    e. Requests for adjustments in the Contract Time or the Contract Sum.
    f. Requests for interpretation of DEN Project Manager's actions on submittals.
    g. Incomplete RFIs or inaccurately prepared RFIs.

2. DEN Project Manager's action may include a request for additional information, in which case DEN Project Manager's time for response will date from time of receipt of additional information.
3. DEN Project Manager's action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Title 11 - Changes In the Work, Contract Price, or Contract Time in the General Contract Conditions, 2011 Edition as amended by Special Conditions.

    a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify DEN Project Manager in writing within five (5) days of receipt of the RFI response or the time required by Title 11 - Changes In the Work, Contract Price, or Contract Time in the General Contract Conditions, 2011 Edition

F. RFI Log: For projects not utilizing the PMIS application, prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. The log shall include but not limited to the following data:

1. Project name.

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2. Name and address of Contractor.
3. Name and address of DEN Project Manager.
4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date DEN Project Manager's response was received.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

PART 4 - MEASUREMENT

4.1 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 additional Payment will be made for compliance with the requirements of this section.

END OF SECTION **013100**

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SECTION 013119 - PROJECT MEETINGS

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. 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.

1.3 REFERENCE DOCUMENTS

A. Form CM-01, Preconstruction Meeting Agenda

B. Form CM-62, Construction Meeting Agenda/Minutes

1.4 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

3.1 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.

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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. 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.

3.2 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

4.1 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 shall be made for work under this Section.

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B. All payments for any Work done under this contract shall be in accordance with Title 9 - Compensation of the General Contract Conditions, 2011 Edition.

END OF SECTION **013119**

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SECTION 013210 - SCHEDULE

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. The Work specified in this Section describes the procedures and requirements for scheduling and documenting the progress of the project:

1. Preliminary Construction Schedule.
2. Initial Project Construction Schedule (IPS).
3. Monthly Progress Schedule update.
4. As-built Schedule.
5. Three-Week Look-Ahead Schedule.
6. Submittal Schedule.
7. Fabrication Schedule.
8. Material Delivery Schedules, cranes, special equipment and staging status.
9. Daily Superintendent/Foreman Reports
10. Daily Quality Control Reports
11. Special reports:

    a. Weather impacts and mitigations.
    b. Recovery Schedule and alternatives.

B. Reference Documents

1. Article 1105 – Time Extensions in the General Contract Conditions, 2011 Edition.
2. Section 011100 "Summary of Work"
3. Section 011420 "Work Sequence and Constraints".
4. Section 012910 "Schedule of Values".
5. Section 013119 “Project Meetings”
6. Section 013300 "Submittal Procedures"

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a Construction Schedule consume time and resources:

B. Contract Time: Total number of days provided in the Contract Documents from the Notice to Proceed to the date of Final Completion of the Work. Substantial Completion

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shall occur prior to Final Completion. Contract Time may be further defined and divided into phases by the Technical Specifications or Special Conditions. The Contract Documents may require completion on or before a certain specified date.

C. Cost Loading: The allocation of the total contract value spread across each appropriate activity. All project costs, including those for stored materials, allowances and indirect costs shall be loaded into the schedule and shall be balanced to where no activity is unfunded.

D. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish dates. Any delay in the start or finish of a critical activity will cause a delay to the project finish.

E. Critical Path Method (CPM): A method of planning and scheduling a construction project where activities are arranged based upon defined relationships. Defined relationships determine when activities can be performed and the critical path for completing the Work.

F. Critical Path: The longest chain of interdependent activities through the network sequence that establishes the shortest duration for completing the work and contains no float. The critical path shall be calculated as total float equal to but not less than zero days. Activities on the critical path have a total float of zero.

G. Data Date: The date on which the schedule status is determined. For initial schedules, it is the project Notice to Proceed date. For schedule updates, it is the reporting period cut-off date. Updated schedules depict the actual status of the work started, on-going and/or completed within the reporting period. The data date is used to start the scheduling calculations for forward and backward passes.

H. Days: Consecutive calendar days unless specifically designated otherwise and includes weekends, holidays or days of normal inclement weather.

I. Direct Man-hours: Man-hours related only to the physical construction of the Work, i.e., drywall, carpeting, electrical, masonry, mechanical, etc.

J. Final Completion: Occurs following Substantial Completion and when the Project Manager confirms in writing that the Contractor has completed the work in accordance with the contract, including completion of all punch list items, cleanup work and delivery of all required guarantees, warranties, licenses, releases and other required deliverables.

K. Free float: The amount of time an activity can be delayed without adversely affecting the early start of its successor activity.

L. Indirect Man-hours: Man-hours related to support of the physical construction of the Work, i.e., mobilization, cleanup, traffic control, temporary activities, badging, supervision and overhead, etc.

M. Lag: The delay of a successor activity and represents time that must pass before the second activity can begin. There are no resources associated with a lag.

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N. Lead: The acceleration of a successor activity where it can begin in parallel with the predecessor activity. It compresses the total combined duration of both activities. The dependency must be discretionary and there is no physical limitation on completing Activity “A” before Activity “B” begins.

O. Longest Path: The longest continuous path of activities through a project, which controls project early completion. It is possible for otherwise defined critical path activities to not be on the longest path and longest path activities to not show calculated critical float.

P. Notice to Proceed: A notification letter from the Owner addressed to the contractor stating the date on which the contractor can begin project work. The NTP date marks the beginning of the Contract Time.

Q. Predecessor Activity: An activity that comes before a dependent activity in the network sequence. It must either start or finish before a specified activity can begin.

R. Resource Loading: A calculated value based on the actual worker’s hours and costs, equipment and materials costs that are required to complete an activity. The value is allocated to the specific activities.

S. Substantial Completion: The Work has progressed to the point that the City can beneficially occupy or utilize the Work for the purpose 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 certificate of suitability for use from the appropriate governmental agencies, as determined by the Manager in its sole discretion.

T. Successor Activity: A dependent activity that logically comes after another activity in the network sequence.

U. Total float: The amount of time that an activity in a network sequence can be delayed without causing a delay to subsequent activities and/or the completion date of the Work.

V. Work Breakdown Structure (WBS): A hierarchical decomposition of the Work to be executed by the contractor. It shall allow for the roll-up and summarization to a predetermined level. The level of breakdown shall be agreed upon by the Contractor and the DEN Project Manager prior to the start of Work.

1.4 SUBMITTALS

A. Submit for City acceptance the following in accordance with Section 01 33 00 – Submittal Procedures:

1. Project Scheduler Qualifications
2. Preliminary Project Construction Schedule
3. Initial Project Construction Schedule
4. Monthly Progress Update Schedules

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5. Time Impact Analysis, when necessary
6. As-built Schedule

B. Scheduler/Scheduling Consultant Qualifications:

1. A professional with a minimum of two (2) years of experience with scheduling 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 also have the ability to produce reports and diagrams within 24 hours of the DEN Project Manager's request and be able to perform the below tasks, including, but not limited to, the following:

    a. Create, maintain and update the project construction schedule.
    b. Prepare monthly progress schedule updates, submit for review and incorporate the City's review comments into the schedule, if any.
    c. Coordinate the participation of qualified personnel to assist in the development of the initial construction schedule and updating of the monthly progress schedule.
    d. Develop a WBS to the appropriate level and be able to discuss verbally and in writing the applicability of the WBS.
    e. Incorporate delivery dates for Owner-furnished products.
    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 time required for Project closeout and Owner start-up procedures, including commissioning activities.

1.5 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 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, and partial Owner occupancy.
4. Review delivery dates for Owner-furnished products.
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,

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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.

B. Coordinate Initial Project Construction Schedule with the Schedule of Values.

C. Work items in the Initial Construction Schedule shall be identified in a Work Breakdown Structure (WBS) format that corresponds with the areas, phasing or schedules of the project and the technical specifications.

D. Secure time commitments for performing critical elements of the Work from entities involved.

E. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.1 SOFTWARE

A. DEN Default Software:

1. DEN shall use Oracle Primavera P6, Release 18.7 for all City scheduling needs.

B. Contractor Software:

1. Scheduling software used by the contractor shall be Oracle Primavera P6 Release 16 or higher.
2. The software and any support agreements shall be purchased at the contractor's expense from a vendor of the contractor's choosing.
3. The City will not provide training or support services for contractor purchased software.

C. Oracle Primavera P6:

1. The following settings are mandatory and required in all schedule submissions to the City:

a. Activity codes shall be Project Level, not Global or EPS level.
b. Calendars shall be Project Level, not Global or Resource level.
c. Activity Duration Types shall be set to "Fixed Duration & Units".
d. Percent Complete Types shall be set to "Physical".
e. Time Period Admin. 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.
f. Set Schedule Option for defining Critical Activities to "Total Float less than or equal to zero (0) hours/day".

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g. Set Schedule Option for defining progressed activities to “Retained Logic”.
h. Set up cost loading using single lump sum resource. 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.
i. Activity ID’s shall not exceed 10 characters.
j. Activity Names shall have the most defining and detailed description within the first 30 characters.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Prepare for acceptance all Project Schedules utilizing the Critical Path Method (CPM) of network calculation to generate all Project Schedules.

B. Prepare each Project Schedule utilizing the Precedence Diagram Method (PDM).

C. Show in the schedule, the proposed sequence to perform the work and dates contemplated for starting and completing the schedule activities.

D. The scheduling of the entire project is required.

E. Provide a schedule that is forward planning as well as a project monitoring tool

F. Contractor management personnel shall actively participate in its development.

G. Subcontractors and suppliers working on the project shall also contribute in developing and maintaining an accurate project schedule.

H. 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.

3.2 COST LOADING

A. Activity cost loading shall be reasonable and without front-end loading.

B. Provide additional documentation to demonstrate reasonableness, if requested by the City.

3.3 WITHHOLDNGS / PAYMENT REJECTION

A. 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.

B. If the DEN Project Manager directs schedule revisions and those revisions have not

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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.

3.4 PROJECT SCHEDULE DETAIL REQUIREMENTS

A. Level of Detail Required

1. Develop the Project Schedule as a Level 4 execution schedule.
2. Level of detail to address major milestones and to allow for satisfactory project planning and execution.
3. Failure to develop the Project Schedule to an appropriate level of detail will result in its disapproval.
4. The DEN Project Manager will consider, but is not limited to, the following characteristics and requirements to determine appropriate level of detail

B. Activity Durations

1. Reasonable activity durations are those that allow the progress of ongoing activities to be accurately determined between update periods.
2. Less than 2 percent of all non-procurement activities shall have Original Durations (OD) greater than 20 work days or 30 calendar days.

C. Procurement Activities

1. Include activities associated with the critical submittals and their approvals, procurement, fabrication and delivery of long lead materials, equipment, fabricated assemblies and supplies.
2. Long lead procurement activities are those with an anticipated procurement sequence of over 30 calendar days.

D. Mandatory Tasks

1. Include the following tasks/activities in the preliminary and initial project schedules and all updates.

    a. Notice to Proceed milestone activity.
    b. Submission, review and acceptance of preconstruction submittals (individual activity for each).
    c. Long procurement activities.
    d. Submission and approval of testing activities, as needed by project.
    e. Submission and approval of Operations & Maintenance (O&M) manuals.
    f. Submission and approval of as-built drawings.
    g. City Punch list walk-through.
    h. Correction of Punch list items based on City Punch list walk-through.
    i. Substantial Completion milestone activity.

E. Owner Activities

1. Show the City and other agency activities that could impact progress. These

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activities include, but are not limited to:

a. Approvals
b. Acceptance
c. Building Department Permits
d. Environmental Permit Approvals by State Regulators
e. Inspections
f. Utility Tie-Ins
g. Owner Furnished Equipment
h. NTP For Phasing Requirements.

F. Workers Per Day

1. Assign workers per day for the field construction and direct work activities, if directed by DEN Project Manager.
2. Workers per day shall be the average number of workers expected each day to perform the task for the duration of the activity.

G. Responsible Party Coding

1. Assign responsibility for activities to the Prime Contractor, subcontractors, DEN or other agencies responsible for performing the activity.
2. Activities cannot have more than one Responsibility Code.
3. Examples of acceptable activity code values are:

a. DOR (Designer of Record)
b. ELEC (electrical subcontractor)
c. MECH (mechanical subcontractor)
d. PAVE (paving subcontractor)
e. DEN (Denver International Airport)

H. Calendars

1. Schedule activities on a calendar to which the activity logically belongs.
2. Develop calendars to accommodate Contract-defined work periods, such as a 7-day calendar for City Acceptance activities, concrete cure times, etc.
3. Develop the default calendar to match the physical work plan with non-work periods identified including weekends and holidays.
4. Develop and assign seasonal calendars to seasonally affected activities.
5. If an activity is weather-sensitive, assign it to a calendar showing non-work days on a monthly basis, with the non-work days selected at random across the weeks of the calendar:

a. The assignment of the non-work days should be over a 7-day week since weather records are compiled on 7-day weeks, which will cause some of the weather related non-work days to fall on weekends.
b. Monthly average rain and snow measurements can be obtained from the National Climatic Data Center for the Denver Metropolitan Area or any similar trusted resource.

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I. Contract Milestones and Constraints

1. Milestone shall be used for significant project events including, but not limited to, project phasing, project start and end activities, and interim milestone and/or completion dates.
2. The use of artificial float constraints such as "zero free float" or "zero total float" are prohibited.
3. Mandatory constraints that ignore or affect network logic are prohibited.
4. No constrained dates are allowed in the schedule other than those specified herein. Submit additional constraints to DEN Project Manager for approval on a case-by-case basis.

J. Project Start Date Milestone

1. The first activity in the project schedule shall be a start milestone titled “NTP Issued” with a date equal to the date that NTP was issued to the contractor.

K. Project Finish Milestone

1. The last activity in the schedule shall be a finish milestone titled “Substantial Completion”.
2. The project schedule shall be constrained to reflect the last day of the contract duration in such a way that if the schedule calculates an early finish, then the float calculation for “Substantial Completion” milestone reflects positive float.
3. If the project schedule calculates a late finish, then the “Substantial Completion” milestone float calculation reflects negative float.
4. The City is under no obligation to accelerate City activities to support a Contractor’s early completion.

L. Interim Completion Dates and Constraints

1. Constrain contractually specified interim milestone completion dates to show negative float when the calculated last finish date of the last activity in that phase is later than the specified interim completion date.

M. Start Phase

1. Use a start milestone as the first activity for a project phase.
2. The start milestone shall be called “Start Phase X” where “X” refers to the phase of work.

N. End Phase

1. Use a finish milestone as the last activity for a project phase.
2. Call the finish milestone “End Phase X” where “X” refers to the phase of work.

O. Open Ended Logic

1. Only two (2) open ended activities are allowed: the first activity "NTP Issued" shall have no predecessor logic, and the last activity "Substantial Completion" shall have no successor logic.

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P. Default Progress Data Disallowed

1. Actual Start and Finish dates shall not automatically update with default mechanisms included in the scheduling software.
2. Updating of the percent complete and the remaining duration of an activity shall be independent functions.
3. Disable program features that calculate one of these parameters from the other. Activity Actual Start (AS) and Actual Finish (AF) dates assigned during the updating process shall match those dates provided in the Contractor Quality Control Reports.
4. Failure to document the AS and AF dates in the Daily Quality Control report will result in disapproval of the Contractor's schedule.

Q. Out-of-Sequence Progress

1. Activities that have been progressed before the preceding logic has been satisfied (Out-of-Sequence Progress) will be allowed only on a case-by-case basis and subject to DEN Project Manager approval.
2. Propose logic corrections to eliminate Out-of-Sequence Progress.
3. Address Out-of-Sequence Progress and logic changes in the Narrative Report and in the periodic schedule update meetings.

R. Added and Deleted Activities

1. Do not delete activities from the project schedule or add new activities to the schedule without approval from the DEN Project Manager.
2. Activity ID and description changes are considered new activities and shall not be changed without approval from the City.

S. Original Durations

1. Activity Original Durations (OD) shall be reasonable to perform the work item. OD changes are prohibited unless justification is provided to and approved by the DEN Project Manager.

T. Leads, Lags, and Start to Finish Relationships

1. Lags shall be reasonable as determined by the DEN Project Controls and not used in place of realistic original durations, shall not be in place to artificially absorb float, or to replace proper schedule logic.
2. Leads (negative lags) and Start to Finish (SF) relationships are prohibited.

U. Retained Logic

1. Schedule calculations shall retain the logic between predecessors and successors ("retained logic" mode) even when the successor activity starts, and the predecessor activity has not finished (out-of-sequence progress).
2. Software features that, in effect, sever the tie between predecessor and successor activities when the successor has started, and the predecessor logic is not satisfied ("progress override") shall not be allowed.

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V. Percent Complete

1. Update the percent complete for each activity started, based on the realistic assessment of earned value.
2. Activities which are complete, but for remaining minor punch list work and which do not restrain the initiation of successor activities may be declared 100 percent complete to allow for proper schedule management.

W. Remaining Duration

1. Update the remaining duration for each activity based on the number of estimated work days necessary to complete the activity.
2. Remaining duration may not mathematically correlate with percentage found under Paragraph "Percent Complete", above.

X. Work Performed Under Adverse Weather Conditions

1. In accordance with the 2011 Denver General Contract Conditions (GCC) Section 305 Work Performed Under Adverse Weather Conditions, adverse weather conditions are those that are not abnormal weather conditions but that can, depending on the Work to be performed, cause defective Work.
2. High and low temperatures, excessive moisture or unusual drying conditions are examples. Reflect the number of anticipated adverse weather days allocated to a weather-sensitive activity in the activity's calendar.
3. These conditions must be recorded in the Contractor Daily QC Reports, notification of adverse weather shall be given within twenty-four (24) hours of occurrence to the DEN Project Manager for concurrence and the adverse weather day documented in order to be considered for a time extension adjustment.

Y. Time Extensions for Abnormal Weather Conditions

1. In accordance with the 2011 Denver General Conditions (GCC) Section 1105 Time Extensions, if abnormal weather conditions are the basis for a request to extend the Contract Time, such request will be documented by data substantiating that weather conditions were unusually severe for the period of time and could not have been reasonably anticipated.
2. To establish that the existence of abnormal weather, the Contractor must submit documentation that establishes that the weather conditions experienced fall outside of the extreme ranges of weather data published by the National Climatic Data Center for the Denver Metropolitan Area for the ten (10) year period immediately preceding the data of the Contract.
3. Regardless of actual weather conditions, any Day in which the Contractor is able to work eighty percent (80%) or more of its scheduled work force shall not be counted as an abnormal weather Day for purposes of calculating weather related time extensions.

Z. Early Completion Schedule and the Right to Finish Early

1. An Early Completion Schedule is an Initial Project Schedule that indicates the

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scope of the required contract work will be completed before the contractually required completion date.

2. An Initial Project Schedule indicating an Early Completion will not be accepted without being fully resource-loaded (including crew sizes and manhours) and without the DEN Project Manager agreeing that the schedule is reasonable and achievable.
3. The City is under no obligation to accelerate its own work items to ensure that the early completion is met nor is it responsible to modify incremental funding (if applicable) for the project to meet the Contractor's accelerated work.

3.5 PROJECT SCHEDULE SUBMISSIONS

A. General

1. Submit the electronic data files (.xer), reports, and network diagrams required for each submission as described in Article 1.4 SUBMITTALS.
2. If the Contractor fails or refuses to furnish the information and schedule updates as set forth, the Contractor will be deemed unresponsive and payment may be withheld as described in Article 3.3 WITHOLDINGS / PAYMENT REJECTION.
3. Review comments made by DEN Project Controls on the schedules do not relieve the Contractor from compliance with the Contract.
4. Provide the submissions as described below.

B. Preliminary Project Construction Schedule Submission

1. Within ten (10) days after the issuance of Notice to Proceed (NTP), submit the Preliminary Project 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 Construction Schedule shall form the basis for the Initial Project Construction Schedule specified herein and shall include all the required plan and program preparations, submissions and approvals identified in the contract. For example, Quality Control Plan, Site-specific Safety Plan, and Environmental Protection Plan, etc.
3. The DEN Project Manager 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 Construction Schedule, the Contractor may, at the Contractor’s own discretion, submit the Initial Project Construction Schedule at the Preconstruction Meeting.

    a. If the Initial Project Construction Schedule is submitted in lieu of the

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Preliminary Project Construction Schedule, the DEN Project Manager will respond within thirty (30) days with acceptance or direction to revise and resubmit within ten (10) days.

5. Acceptance of Preliminary Project Construction Schedule will not constitute approval of Schedule of Values.

C. Gantt Chart Schedule

1. Submit a time-scaled network diagram printout of the Preliminary Project Construction Schedule at the pre-construction meeting.

2. Preparation

a. Indicate each significant construction activity separately.
b. Identify first workday of each week with a continuous vertical line.
c. Outline significant construction activities for the contract duration.
d. Include skeleton diagram for the remainder of the Work, when necessary.
e. For a project with contract time greater than 120 calendar days, the Preliminary Schedule shall show all significant Work tasks that occur in the first sixty (60) days including, but not limited to planning, mobilization, shop drawings and technical submittals and approval time, procurement, fabrication and construction.
f. For a project with contract time less than 120 calendar days, the Preliminary Schedule shall show all Work tasks that occurs during the contract time including, but not limited to planning, mobilization, shop drawings and technical submittals and approval time, procurement, fabrication and construction.
g. It shall identify work items or milestones that affect or are affected by City, other Contractor's work, utilities, and other third parties and it shall list major submittals required by the Contract.

D. Narrative Report

1. For a project with contract time greater than 120 calendar days, the Preliminary Project Construction Schedule shall be accompanied by a narrative describing the Contractor's approach to mobilization, procurement, and construction during the first sixty (60) days.
2. For a project with contract time less than 120 calendar days, the Preliminary Project Construction Schedule shall be accompanied by a narrative describing the Contractor's approach to mobilization, procurement, and construction during the contract time.
3. The narrative shall elaborate based on durations, production rates, major equipment to be used, and shall identify all major assumptions used to develop the schedule.

3.6 Initial Project Construction Schedule Submission

A. General

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1. Submit the Initial Project Construction Schedule for acceptance within thirty (30) 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 Construction Schedule shall become the Baseline Schedule for the duration of the project.
6. The Baseline Project 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 Contractor elects to change the sequence or duration of work items affecting the critical path resulting in a major change that requires DEN PM 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 Contractor from completing all Work within applicable completion dates, regardless of the City's acceptance of the schedule.
8. Failure of the contractor to have an Initial Project Construction Schedule accepted by DEN Project Manager will be considered cause for withholding progress payment.

B. Preparation:

1. Project Duration

    a. Extend schedule from NTP date to Substantial Completion.
    b. Contract completion date shall not be changed by submission of a schedule that shows an early or late completion date, unless specifically amended by Change Order.

2. Activities

    a. Treat each building floor or separate area as a separate numbered activity for each main element of the Work.
    b. Prepare a list of all activities required to complete the Work and indicate the estimated time duration, sequence requirements, and relationships of each activity in relation to the other activities.

3. Activity Duration:

    a. Define activities so no construction activity is longer than twenty (20) days, unless specifically allowed by DEN Project Manager. Include estimated

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time frames for the following activities:

1) Preparation and processing of submittals.
2) Mobilization and demobilization.
3) Purchase of materials.
4) Delivery of materials.
5) Fabrication of materials
6) System shutdown request and approval
7) Utility/system interruptions
8) Installation of Work
9) Work by City, other contractors, utilities and other third parties that may affect or be affected by Contractor's activities.
10) Startup, Testing and Commissioning
11) Punch list and Final Completion.

4. Critical Path Activities:

   a. No more than twenty-five (25) percent of the activities may be on the critical path, unless approved IN WRITING by DEN Project Manager.
   b. Identify critical path activities, including those for interim completion dates.
   c. Scheduled start and completion dates shall be consistent with Contract milestone dates.

5. Procurement Activities:

   a. Include procurement activities for long lead items and major items as separate activities in schedule.
   b. Procurement cycle activities including, but are not limited to, submittals, approvals, purchasing, fabrication and delivery.
   c. May have a duration greater than twenty (20) calendar days and should represent the time to complete the procurement cycle as described above.

6. Submittal Review Time:

   a. Include review and re-submittal times indicated in Technical Specification 013300 "Submittal Procedures" in schedule unless time frame is reduced by approval of the DEN Project Manager.
   b. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.

7. Substantial Completion:

   a. Indicate date established for Substantial Completion.

8. Milestones:

   a. Include milestone indicated in the Contract Documents, including, but not limited to, NTP, Phasing Milestones and Substantial Completion.

9. Constraints:

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a. Include constraints and work restrictions indicated in the Contract Documents and show how the sequence of the Work is affected:

1) Phasing:

a) Arrange activities in schedule in Work Breakdown Structure (WBS) by Area, Phase or Bid Schedule.
b) Coordinate phasing and constraints with those established in Technical Specification Section 011400 “Work Sequence and Constraints”.

2) Products Ordered in Advance:

a) Include separate activity for each product.
b) Include delivery date indicated in Technical Specification Section 011100 “Summary of Work”.
c) Delivery dates indicated stipulate the earliest possible delivery data.

3) Owner-furnished Products:

a) Include separate activity for each product.
b) Include delivery date indicated in Technical Specification Section 011100 “Summary of Work”.
c) Delivery dates indicated stipulate the earliest possible delivery date.

10. Resource Loading of Construction Schedule:

a. Coordinate with DEN Project Controls and DEN Project Manager for the requirements.
b. Activities shall be resource loaded with direct man-hours required to perform the physical construction of the project. Indirect man-hours shall not be included as resources to activities.

C. Schedule Narrative Report

1. The Initial Project Construction Schedule shall be accompanied by a narrative describing the Contractor’s approach to mobilization, procurement, and construction for the project.
2. It shall elaborate on the original assumptions of estimated quantities and production rates, hours per shift, workdays per week, and types, number and capacities of major construction equipment to be used and whether the Contractor plans to work weekends.

3.7 MONTHLY PROGRESS CONSTRUCTION SCHEDULE UPDATES

A. The Contractor shall submit a monthly progress schedule at the end of each month following the issuance of NTP.

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B. 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.

C. 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 Construction Schedule.

D. Failure of the Contractor to have a Monthly Progress 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.

E. The Contractor's monthly progress schedule shall include a written narrative describing the overall progress of the Work, provide a critical path analysis, explain the basis for determining construction logic, discuss significant problems with proposed corrective action, and how the status of major changes and any other changes are affecting the project schedule.

F. Concurrent with making revision to the schedule, prepare a tabulated report showing the following and include in the narrative report:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations for remaining work activities only.
5. Changes in critical path.
6. Change in total float
7. Changes in contract time.

G. Minor revisions submitted at monthly progress review meeting are not considered as changes in this context.

H. If after submitting a request for change to the Construction Schedule, the DEN Project Manager does not agree with the request, the DEN Project Manager will schedule a meeting with the Contractor to discuss the differences.

I. If a settlement cannot be reached on the change in the Construction Schedule, or if the Contractor has failed to submit revisions to the network, the DEN Project Manager has the option of providing suggested logic or duration changes in all subsequent update schedules.

J. The suggested logic and/or duration times will remain in effect until the change in the Construction Schedule is settled or until the logic and duration are superseded.

3.8 THREE WEEK LOOK-AHEAD SCHEDULE

A. 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

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Schedule for review at the DEN Project Manager's weekly progress meeting.

B. The schedule shall be generated from Primavera P6 in time-scaled network diagram bar chart format based on the approved accepted CPM Baseline Project Schedule and shall include dates of activities in progress, work to be completed within the period, percent complete of activities, and responsible subcontractor for the activities, testing activities, and anticipated dates of inspection by DEN and other agencies.

3.9 AS-BUILT CONSTRUCTION SCHEDULE:

A. 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.

B. The basis for the As-built Construction schedule will be the approved Monthly Progress Schedules.

3.10 RECOVERY SCHEDULE

A. When a monthly progress schedule update indicates the Work is behind the current approved schedule, submit a separate Recovery Schedule indicating means by which Contractor intends to regain compliance with the schedule.

B. 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.

C. 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 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.

D. 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.

E. The narrative shall be submitted in accordance with Article 1105 – Time Extensions in the General Contract Conditions, 2011 Edition.

3.11 REQUEST FOR TIME EXTENSION

A. General:

1. Provide a justification of delay to the DEN Project Manager, in accordance with

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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 Contractor to a Time Extension, unless the 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 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 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

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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 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.

3.12 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

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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

4.1 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.

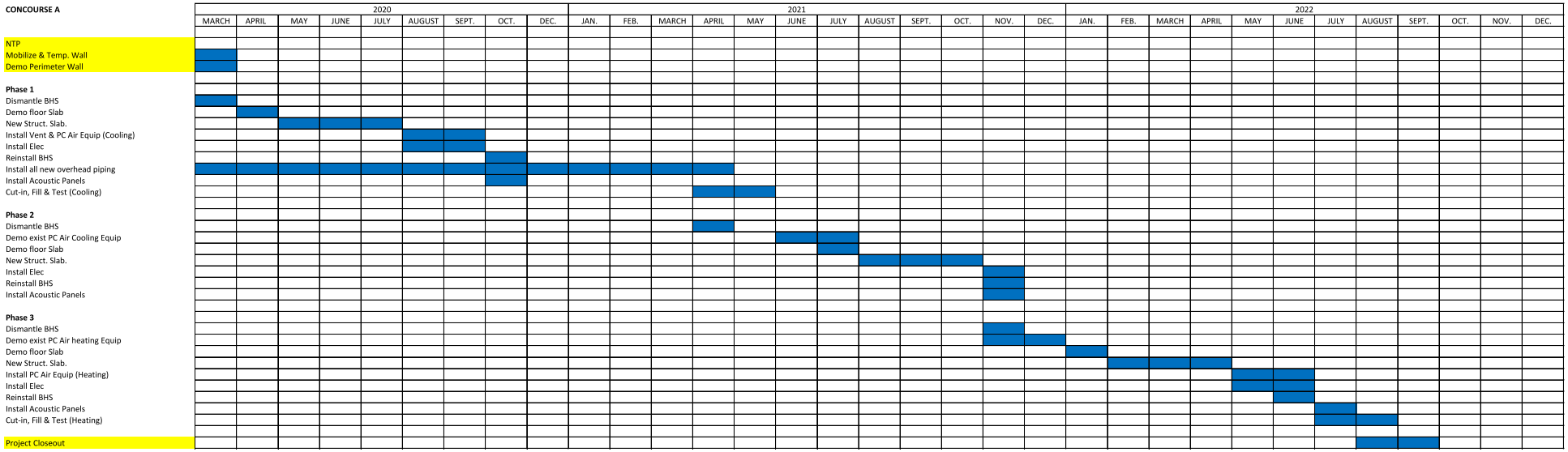
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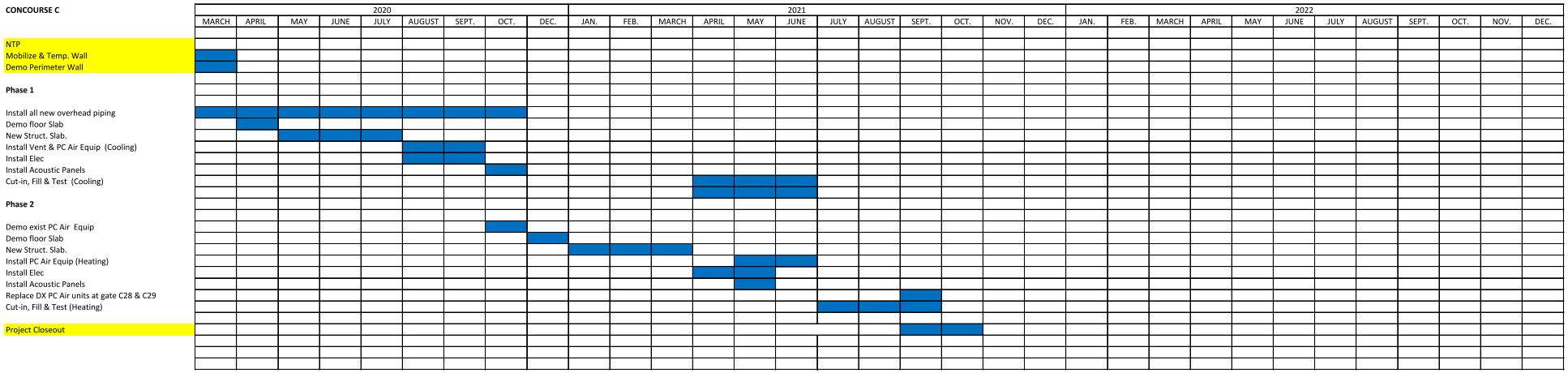
CCA & CCC PC AIR PLANT RELIFE

DESIGN PRELINARY CONSTRUCTION SCHEDULE 6/20/2019

CONCOURSE A



CONCOURSE C



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SECTION 013223.11 – CONSTRUCTION LAYOUT AND AS-BUILT SURVEYS

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 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. Survey Project Checklist, provided as part of this Specification, must be reviewed at the pre-survey preparation activities meeting. (Refer to Article 1.11.)

1.3 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

1.4 SUBMITTALS

A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for the submittal process.

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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.

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4. As-built or as-constructed survey submittals must 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.

1.5 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.

1.6 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

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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.

1.7 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. 1. All angle points or changes of directions.
2. 2. At the beginning and ending of curves.
3. 3. At the points of change of direction or changes of radius of any boundary defined by circular arcs.
4. 4. Not to exceed 1400 feet apart along any straight boundary line.
5. 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. 1. DEN Project Code number
2. 2. Point number as shown on the Right of Way Plans
3. 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

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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.

1.8 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

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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

1.9 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

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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.

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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?

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 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.

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PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment must be made for work under this Section. The cost of the work described in this Section must be included in the applicable contract value, work order or lump sum bid item.

END OF SECTION 013223.11

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SECTION 013223.15 – SURVEY INFORMATION

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 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.

1.3 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

1.4 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):

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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”.

1.5 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.

1.6 SURVEY CONTROL

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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

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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.

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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.

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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.

1.7 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

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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. If.

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)

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PART 3 - Execution (Not Used)

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.

END OF SECTION 013223.15

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SECTION 013223.19 QUANTITY SURVEYS

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 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.

1.3 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

1.4 SUBMITTALS

A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for the submittal process.

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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.

1.5 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

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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

3.1 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

4.1 METHOD OF MEASUREMENT

A. No separate measurement must 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 must be included in the applicable unit price item, work order or lump sum bid item.

END OF SECTION 013223.19

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SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

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. Section includes administrative and procedural requirements for the following:

1. Preconstruction photographs.
2. Periodic construction photographs.
3. Final Completion construction photographs.
4. Preconstruction video recordings.
5. Periodic construction video recordings.
6. Web-based construction photographic documentation.

1.3 REFERENCE DOCUMENTS:

A. Section 013300 "Submittal Procedures"

B. Section 017720 "Contract Closeout"

C. Section 017900 "Demonstration and Training"

D. Section 024116 "Structure Demolition"

E. Section 024119 "Selective Demolition"

F. Section 311000 "Site Clearing"

1.4 ALTERNATES

A. Refer to Section 012300 "Alternates"

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**photographer**] [**and**] [**Web-based photographic documentation service provider**].

B. Key Plan: Submit key plan of Project site and building with notation of vantage points

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marked for location and direction of each [**photograph**] [**video recording**]. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

C. Digital Photographs: Submit image files within [**three (3)**] <**Insert number**> days of taking photographs.

1. Digital Camera: Minimum sensor resolution of [**10**] <**Insert number**> megapixels.
2. File Format: Minimum <**Insert resolution**> pixels, in unaltered .RAW original files, with same aspect ratio as the sensor, uncropped, date and time stamped, in folder named by date of photograph, accompanied by key plan file.
3. Identification: Provide the following information with each image description in file metadata tag:

    a. Project title and Project number.
    b. Name and contact information for photographer.
    c. Name of DEN Project Manager.
    d. Name of Contractor.
    e. Date photograph was taken.
    f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

        1) Include work order number or change order number if applicable.

    g. Unique sequential identifier keyed to accompanying key plan.
    h. Photograph number.

D. Construction Photographs: Submit [**two (2)**] <**Insert number**> prints of each photographic view within [**seven (7)**] <**Insert number**> days of taking photographs.

1. Format: **[**8-by-10-inch]<**Insert size**>. smooth-surface matte prints on single-weight, commercial-grade photographic paper; [**mounted on linen or card stock to allow a** 1-inch-**wide margin and**] [**enclosed back to back in clear plastic sleeves that are**] punched for standard three-ring binder.
2. Identification: On back of each print, provide an applied label or rubber-stamped impression with the following information:

    a. Name of Project.
    b. Name and contact information for photographer.
    c. Name of DEN Project Manager.
    d. Name of Contractor.
    e. Date photograph was taken if not date stamped by camera.
    f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    g. Unique sequential identifier keyed to accompanying key plan.

E. Video Recordings: Submit video recordings within [**seven (7)**] <**Insert number**> days of recording.

1. Submit video recordings in an electronic format acceptable to DEN Project

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Manager [**by posting to Project Web site**] [**by posting to Web-based photographic documentation service provider's Web site**]. Recordings shall be high-resolution [**720p**] [**1080p**][**4k**][**8k**] with a minimum framerate of 60Hz

2. Identification: With each submittal, provide the following information:

    a. Name of Project.
    b. Name and address of photographer.
    c. Name of DEN Project Manager.
    d. Name of Contractor.
    e. Date video recording was recorded.
    f. Description and key plan of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    g. Weather conditions at time of recording.

F. Web-Based Photographic Documentation: Submit time-lapse sequence video recordings [**simultaneously with recording**] [**within** <**Insert number**> **days of recording**].

1. Submit time-lapse sequence video recordings by posting to [**Project Web site**] [**Web-based photographic documentation service provider's Web site**] <**Insert posting location**> [**and monthly in digital format**].
2. Identification: For each recording, provide the following information:

    a. Name of Project.
    b. Name and contact information for photographer.
    c. Name of DEN Project Manager.
    d. Name of Contractor.
    e. Date(s) and time(s) video recording was recorded.
    f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    g. Weather conditions at time of recording.

1.6 QUALITY ASSURANCE

A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

B. Web-Based Photographic Documentation Service Provider: A firm specializing in providing photographic equipment, Web-based software, and related services for construction projects, with record of providing satisfactory services similar to those required for Project for not less than three years.

1.7 USAGE RIGHTS

A. Obtain and transfer copyright usage rights from photographer to City and County of Denver for unlimited reproduction of photographic documentation.

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PART 2 - PRODUCTS

2.1 PHOTOGRAPHIC MEDIA

A. Digital Images: Provide images in JPG format, produced by a digital camera with minimum sensor size of [**10**] <**Insert number**> megapixels, and at an image resolution of not less than [**3200 by 2400**] <**Insert resolution**> pixels.

B. Digital Video Recordings: Provide high-resolution [**720p**] [**1080p**][**4k**][**8k**] with a minimum framerate of 60Hz in electronic format acceptable to DEN Project Manager.

2.2 WEB-BASED PHOTOGRAPHIC DOCUMENTATION

A. Project Camera: Provide fixed exterior camera installation, mounted to provide unobstructed view of construction site from location approved by DEN Project Manager.

1. Provide [**one**] <**Insert number**> fixed-location camera(s), with the following characteristics:

    a. [**Static view**] [**Remotely controllable view with mouse-click user navigation for horizontal pan, vertical tile, and optical zoom of** [**500**] <**Insert number**> **percent minimum**].
    b. Provide power supply, active high-speed data connection to service provider's network, and static public IP address for each camera.

B. Wireless Hand-Held Camera: Provide portable camera system capable of producing images complying with requirements in this Section, with wireless transmission to service provider's network enabling a live image stream viewable by multiple parties.

1. Provide battery charger, spare battery pack, base station hub, and base station connections in a number and distribution adequate to enable wireless camera operation throughout Project site. Contractor responsible for ensuring camera stays in operation.
2. Provide power supply, active high-speed data connection to service provider's network, and static public IP address at base station hub. Provide power supply, conduit, and data wiring between base station hub and base station connections.

C. Web-Based Image Access: Password-protected access for Project team administered by Contractor, providing current image access and archival image access by date and time, with images downloadable to viewer's device.

1. Provide public viewer open access to most recent project camera image.

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PART 3 - EXECUTION

3.1 CONSTRUCTION PHOTOGRAPHS

A. Photographer: Engage a qualified photographer to take construction photographs.

B. General: Take photographs using the maximum range of depth of field, and that are in focus, to show clearly the Work. Photographs with blurry or out-of-focus areas will not be accepted.

1. Maintain key plan with each set of construction photographs that identifies each photographic location.

C. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software. Provide commercial quality, digital color photographs in PDF format. PDF file shall be security-free, bookmarked by date with all photos rotated to the correct orientation. Identify the following information on each photograph on the lower right corner.

1. Subject description (include work order number or change order number if applicable)
2. Station point of camera and direction of view. Include letter size diagram of project indicating Station point
3. Date and time each photo was taken
4. Name of Contractor.
5. Photograph number
6. Field Office Images: Maintain one set of images accessible in the field office at Project site, available at all times for reference. Identify images in the same manner as those submitted to DEN Project Manager.

D. Preconstruction Photographs: Before [**commencement of excavation**] [**commencement of demolition**] [**starting construction**], take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by DEN Project Manager.

1. Flag [**excavation areas**] [**construction limits**] before taking construction photographs.
2. Take [**20**] <**Insert number**> photographs to show existing conditions adjacent to property before starting the Work.
3. Take [**20**] <**Insert number**> photographs of existing buildings either on or adjoining property to accurately record physical conditions at start of construction.
4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.
5. Haul route, laydown yard, and other locations as directed by DEN Project Manager.

E. Periodic Construction Photographs: Take [**20**] <**Insert number**> photographs

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[**monthly, coinciding**] [**weekly, with timing each month adjusted to coincide**] <**Insert time interval**> with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last photographs were taken.

F. DEN Project Manager-Directed Construction Photographs: From time to time, DEN Project Manager will instruct photographer about number and frequency of photographs and general directions on vantage points. Select actual vantage points and take photographs to show the status of construction and progress since last photographs were taken.

G. Time-Lapse Sequence Construction Photographs: Take [**20**] <**Insert number**> photographs as indicated, to show status of construction and progress since last photographs were taken.

1. Frequency: Take photographs [**monthly, coinciding**] [**weekly, with timing each month adjusted to coincide**] <**Insert time interval**> with the cutoff date associated with each Application for Payment.
2. Vantage Points: Following suggestions by DEN Project Manager and Contractor, photographer to select vantage points. During each of the following construction phases, take not less than [**two**] <**Insert number**> of the required shots from same vantage point each time to create a time-lapse sequence as follows:

    a. Commencement of the Work, through completion of subgrade construction.
    b. Above-grade structural framing.
    c. Exterior building enclosure.
    d. Interior Work, through date of Substantial Completion.

H. Final Completion Construction Photographs: Take [**20**] <**Insert number**> color photographs after date of Substantial Completion for submission as project record documents. DEN Project Manager will inform photographer of desired vantage points.

1. Do not include date stamp.

I. Additional Photographs: DEN Project Manager may request photographs in addition to periodic photographs specified. Additional photographs shall be paid for by Change Order and are not included in the Contract Sum.

1. Three days' notice shall be given, where feasible.
2. In emergency situations, take additional photographs within 24 hours of request.
3. Circumstances that could require additional photographs include, but are not limited to, the following:

    a. Special events planned at Project site.
    b. Immediate follow-up when on-site events result in construction damage or losses.
    c. Photographs to be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.
    d. Substantial Completion of a major phase or component of the Work.
    e. Extra record photographs at time of final acceptance.

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f. DEN's request for special publicity photographs.

3.2 CONSTRUCTION VIDEO RECORDINGS

A. Video Recording Photographer: Engage a qualified videographer to record construction video recordings.

B. Recording: Mount camera on tripod before starting recording unless otherwise necessary to show area of construction. Display continuous running time and date. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.

C. Narration: Describe scenes on video recording by [**audio narration by microphone while**] [**dubbing audio narration off-site after**] video recording is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.

1. Confirm date and time at beginning and end of recording.
2. Begin each video recording with name of Project, Contractor's name, videographer's name, and Project location.

D. Preconstruction Video Recording: Before starting [**excavation**] [**demolition**] [**construction**], record video recording of Project site and surrounding properties from different vantage points, as directed by DEN Project Manager.

1. Flag [**excavation areas**] [**construction limits**] before recording construction video recordings.
2. Show existing conditions adjacent to Project site before starting the Work.
3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of [**excavation**] [**demolition**] [**construction**].
4. Show protection efforts by Contractor.

E. Periodic Construction Video Recordings: Record video recording [**monthly, coinciding**] [**weekly, with timing each month adjusted to coincide**] <**Insert time interval**> with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last video recordings were recorded. Minimum recording time shall be [**30**] <**Insert number**> minutes(s).

F. Time-Lapse Sequence Construction Video Recordings: Record video recording to show status of construction and progress.

1. Frequency: During each of the following construction phases, set up video recorder to automatically record one frame of video recording every [**five (5)**] <**Insert time**> minutes, from same vantage point each time, to create a time-lapse sequence of [**30 minutes**] <**Insert time**> in length as follows:

a. Commencement of the Work, through completion of subgrade construction.
b. Above-grade structural framing.

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c. Exterior building enclosure.

2. Timer: Provide timer to automatically start and stop video recorder so recording occurs only during daylight construction work hours.
3. Vantage Points: Following suggestions by DEN Project Manager [**and Contractor**], photographer shall select vantage points.

3.3 WEB-BASED CONSTRUCTION PHOTOGRAPHIC DOCUMENTATION

A. Live Streaming Construction Site Images: Provide Web-accessible image of current site image from [**fixed**] [**viewer-controlled**] location camera(s), updated at [**15**] <**Insert number**> minute intervals during daytime operation.

B. Time-Lapse Sequence Construction Site Recordings: Provide video recording from a fixed-location camera to show status of construction and progress.

1. Frequency: Record one frame of video recording every [**15**] <**Insert number**> minutes, from same vantage point each time, to create a time-lapse sequence of construction activities.
2. Timer: Provide timer to automatically start and stop video recorder so recording occurs only during daylight construction work hours.

C. Maintain cameras and Web-based access in good working order according to Web-based construction photographic documentation service provider's written instructions until Final Completion. Provide for service of cameras and related networking devices and software.

PART 4 - MEASUREMENT

4.1 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.

END OF SECTION **013233**

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SECTION 013300 - SUBMITTAL PROCEDURES

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. 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.

1.3 SUBMITTAL SCHEDULE

A. The Contractor shall provide a submittal schedule within 14 days after Notice to Proceed. The Submittal Schedule shall be directly related to the CPM schedule, shall identify all the submittals, and shall include the following information for each submittal item

1. Specification section, Contract article, or special condition.
2. Specification Subparagraph.
3. Item description.
4. Date the submittal shall be submitted.
5. Name of subcontractor or supplier.

B. The submittal schedule shall be kept current by the Contractor and submitted with the progress payment requests.

C. For large files that cannot be loaded or e-mailed through the electronic Project Manager application (Unifier), submit the files on a CD, DVD, or USB flash drive media.

1.4 ELECTRONIC SUBMITTALS

A. Before the initiation of the submittal process, coordinate and insure that all submittals comply and follow the requirements of the DEN Building Information Modeling (BIM) Design Standards Manual (DSM) and the DEN BIM PXP.

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B. Submit request for progress payment applications utilizing TEXTURA software as instructed by DEN Project Manager.

C. Submit Subcontractor's Contract information required by the City and County of Denver Small Business Office as instructed by DEN Project Manager.

D. Submit original electronic copies of all City and County of Denver Development Department/ Building Inspection Department Approved drawings including all approvals of Deferred Submittals; including but not limited to shoring plans, Fire Protection distribution plans, and structural shop drawings to DEN Project Manager as Informational Submittals. The lack of approval of the Denver Development Services on any document shall be basis for rejection of Work and non-compliance.

1. NOTE: Only original copies shall be accepted. Scans will not be accepted.

E. Submit electronically scanned copies of all documents required by Chapter 17 "Special Inspection and Testing" of the International Building Code 2009 as amended by City and County of Denver 2011. Keep scale and clarify dimension where electronic copies are not as originally scaled and dimensioned.

F. All submittals shall be delivered to the DEN Project Manager utilizing the Primavera Construction Manager program (PCM) as attachments and as separate file when files are too large to attach or of an electronic media that is not supported by PCM or Utilizing the EPPM Unifier software uploaded to the share drive Unifier's project site when directed by DEN Project Manager.

1. Acceptable electronic formats

a. Print document format (pdf) shall have no security and bookmark every applicable submittal. All pages shall be completely legible and oriented to correct reading view.

2. Formats are acceptable only with written permission of the DEN Project Manager or required by the BIM PXP. For files in any of the following formats, the corresponding stringency will apply:

a. Microsoft Office 2007 or newer. All files shall be fully compatible with Microsoft Office 2007.

1) AutoCAD files shall be self-contained with no external x-references.

b. BIM files shall conform to the standards and formats outlined in the BIM PXP and DEN BIM DSM.
c. Other files pre-approved by the DEN Project Manager.

1.5 INITIAL SUBMITTAL

A. Each submittal document shall include a title block showing the following information:

1. Date of submittal and revision dates.

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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. 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.

F. Changes in accepted submittal documents will not be permitted unless those changes have been accepted, in writing, by the DEN Project Manager.

G. The form and quality of submittal documents shall comply with Section 013325 "Shop and Working Drawings, Product Data, and Samples."

1.6 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.

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 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.

3.2 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 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.

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.

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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.

3.3 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.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

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PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section.

END OF SECTION **013300**

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SECTION 013325 - SHOP AND WORKING DRAWINGS, PRODUCT DATA, AND SAMPLES

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. 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”

1.3 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.

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c. AutoDesk AutoCAD 2007 or newer. All files shall be fully compatible with AutoDesk AutoCAD 2007.
d. AutoCAD files shall be self-contained with no external x-references.
e. BIM format outlined in the BIM Project Execution Plan (PXP)
f. 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.

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1.4 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."

1.5 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 BIM DSM for other requirements that may be applicable to this Article.

PART 2 - PRODUCTS.

2.1 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

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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."

2.2 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."

2.3 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

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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

3.1 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."

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3.2 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.

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. .

END OF SECTION **013325**

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SECTION 013510 - CONSTRUCTION SAFETY

PART 2 - GENERAL

2.1 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.

2.2 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 DEN Rolling Owner Controlled Insurance Program (ROCIP) reference the Contract Special Conditions for all safety requirements.

C. For projects enrolled under DEN Owner Controlled Insurance Program (OCIP) reference the Contract Special Conditions for all safety requirements.

2.3 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.

2.4 SUBMITTALS

A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples” for the submittal process. The Contractor's Site Specific Safety Plan shall be submitted and approved under the general Contract prior to commencing any Work. If a Task Order or Change Order is issued where the Work is not covered by the approved 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.

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1. No progress payment shall be approved until the Contractor's Site Specific Safety Plan has been accepted by the DEN Project Manager.

B. The Contractor shall provide six (6) copies of 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. The Contractor's program must meet, as a minimum, all applicable federal, state and local government requirements, and the following:

1. 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. 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.

   e. The Contractor shall show how material shall be stored beside the excavation. Stored material shall include the excavated and backfilled material
   f. Injury and accident handling, including samples of the reporting form.
   g. 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.
   h. 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.
   i. How and when all electric devices will be checked for proper grounding and insulation. Describe the methods that will be used to lock out electric systems that should not be energized.
   j. How trash and human organic waste will be disposed of.
   k. How snow and ice will be removed by the Contractor in the project area.
   l. How concrete forms will be anchored to ensure their stability, including calculations showing that the forms will safely hold the maximum construction loads.

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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 working above ground level will be protected from falling.
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. The type of personal protective equipment that will be used to protect personnel from hazards.
w. The type of safety training that will be provided to personnel to inform them of safe work procedures.
x. How daily audits and inspections will be performed to ensure compliance with the Contractor's Site Specific Safety Plan and current, applicable OSHA regulations.
y. 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.

z. How compressed gases will be safely stored, handled, and used.
aa. 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.

bb. How the hazards of chemicals will be communicated to personnel, including the use of material safety data sheets and chemical labels.
cc. Methods to ensure that forklifts and other powered industrial trucks are operated in a safe manner.
dd. How an effective hearing conservation program will be used to protect personnel from high noise levels and prevent hearing loss.
ee. How personnel will be protected from the effects of jet blast.
ff. How hazards will be identified and corrected when reported.

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2.5 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.

PART 3 - PRODUCTS (NOT USED)

PART 4 - EXECUTION

4.1 IMPLEMENT CONTRACTOR'S OPERATIONAL SAFETY PLAN

A. Implement the approved Contractor's Operational Safety Plan as described in Article 1 of this Section and in Section 011100 "Summary of Work."

B. If the Contractor experiences lost time or an 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 rates.

C. If at any time the lost time or injury rates experienced by the Contractor are 150 percent or more of the national average for construction, the Contractor shall notify the DEN Project Manager and immediately hire an independent safety professional who shall audit the Contractor's procedures and operations and make a report of changes that the Contractor should implement to reduce the rate including changing personnel.

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.

4.2 ROLLING OWNER CONTROLLED INSURANCE PROGRAM (ROCIP)

A. Implement Rolling Owner Controlled Insurance Program (ROCIP) as provided in the Project Manual issued for bid or proposal

4.3 OWNER CONTROLLED INSURANCE PROGRAM (OCIP)

A. Implement Owner Controlled Insurance Program (OCIP) as provided in the Project Manual issued for bid or proposal

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PART 5 - MEASUREMENT

5.1 METHOD OF MEASUREMENT

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

PART 6 - PAYMENT

6.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section.

END OF SECTION 013510

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SECTION 013516 - ALTERATION PROJECT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes special procedures for alteration work.

1.3 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.

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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.

1.4 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.

1.5 PROJECT MEETINGS FOR ALTERATION WORK

A. Preliminary Meeting for Alteration Work: Before starting alteration work, [**conduct**] [**DOR will conduct**] [**DEN Project Manager**] **will conduct**] meeting at [**Project site**] <**Insert location**>.

1. Attendees: In addition to representatives of City,[**DEN Project Manager,**] DOR, and Contractor, testing service representative, and specialists shall be represented at the meeting.
2. Agenda: Discuss items of significance that could affect progress of alteration

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work, including review of the following:

a. Alteration Work Subschedule: Discuss and finalize; verify availability of materials, specialists' personnel, equipment, and facilities needed to make progress and avoid delays.
b. Fire-prevention plan.
c. Governing regulations.
d. Areas where existing construction is to remain and the required protection.
e. Hauling routes.
f. Sequence of alteration work operations.
g. Storage, protection, and accounting for salvaged and specially fabricated items.
h. Existing conditions, staging, and structural loading limitations of areas where materials are stored.
i. Qualifications of personnel assigned to alteration work and assigned duties.
j. Requirements for extent and quality of work, tolerances, and required clearances.
k. Embedded work such as flashings and lintels, special details, collection of waste, protection of occupants and the public, and condition of other construction that affects the Work or will affect the work.

3. Reporting: [**Record**] [**DOR will record**] [**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 [**weekly**] [**monthly**] <**Insert interval**> 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

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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.

1.6 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**] <**Insert location**>.

1.7 INFORMATIONAL SUBMITTALS

A. Alteration Work Subschedule:

1. Submit alteration work subschedule within [**seven**] [**30**] <**Insert number**> days of date established for[**commencement of alteration work**] <**Insert requirement**>.

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**] <**Insert time**> before work begins.

D. Fire-Prevention Plan: Submit [**30 days**] <**Insert time**> before work begins.

1.8 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**] <**Insert number**> recent projects

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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

1.9 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 [**on-site**] [**off-site**] [**indicated on Drawings**].
5. Protect items from damage during transport and storage.

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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 [**includes**] [**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**] <**Insert requirement**>.

1. Comply with requirements specified in Section 013233 "Photographic Documentation."

B. Discrepancies: Notify DEN Project Manager of discrepancies between existing conditions and Drawings before proceeding with removal and dismantling work.

C. DEN's Removals: Before beginning alteration work, verify in correspondence with DEN Project Manager that the following items have been removed:

1. <**Insert items to be removed by DEN**>.

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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**] <**Insert dimension**> or more.

PART 2 - PRODUCTS - (Not Used)

PART 3 - EXECUTION

3.1 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.

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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**].

3.2 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**] <**Insert requirement**> 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,

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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**] <**Insert time**> after conclusion of work[**in each area**] to detect hidden or smoldering fires and to ensure that proper fire prevention is maintained.
    e. Maintain fire-watch personnel at[**each area of**] Project site until [**60 minutes**] [**two hours**] <**Insert time**> 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.

3.3 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.

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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.

3.4 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.

END OF SECTION **013516**

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A. Copyright 2010 by The American Institute of Architects (AIA)**SECTION 013520 - CONSTRUCTION SAFETY - AIRSIDE**

PART 2 - GENERAL

2.1 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.

2.2 SUMMARY

A. Work specified in this Section includes construction safety precautions and programs by the Contractor for airside, and the basis for reviews by the DEN Project Manager.

B. Related Specification Sections:

1. Section 011420 "Security Requirements and Sensitive Security Information".
2. Section 011430 "Vehicle and Equipment Permitting".
3. Section 011810 "Utilities Interface".
4. Section 013510 "Construction Safety".

C. For projects enrolled under DEN Rolling Owner Controlled Insurance Program (ROCIP) reference the Contract Special Conditions for all safety requirements.

D. For projects enrolled under DEN Owner Controlled Insurance Program (OCIP) reference the Contract Special Conditions for all safety requirements.

2.3 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.

2.4 SUBMITTALS

A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and

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Working Drawings, Product Data and Samples" for the submittal process. The Contractor's Operational Safety Plan shall be submitted and approved under the general Contract prior to commencing any Work. If a Task Order or Change Order is issued where the Work is not covered by the approved Contractor's Operational Safety Plan, then a revision to the Safety Plan specific for the Work in the Task Order shall be resubmitted for approval.

1. No progress payment shall be approved until the Contractor's Operational Safety Plan has been accepted by the DEN Project Manager.

B. Scope: The Contractor's Operational Safety Plan shall be developed and submitted by the contractor for the DEN Project Manager's review and approval. The Operational Safety Plan shall be developed according to the guidelines and requirements provided in FAA AC No. 150/5370-2F "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 Operational 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.

C. 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 AC 150/5300-13A): 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.

D. Policy: Aviation safety is a primary consideration during airport construction. These activities shall be planned and scheduled to minimize disruption of normal aircraft activities. If the clearances and restrictions described in this plan cannot be maintained

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while construction is underway, action will be taken by the Contractor to perform Work at night or during periods of minimal aircraft activity.

E. Safety Impacts: 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 FAA AC 150/5300-13A.
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.

F. Safety Requirements:

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1. General:

    a. 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.
    b. Contractor personnel, airport staff and field inspectors directly involved in on-airport construction shall:

        1) Be aware of the types of conditions, safety problems, and/or hazards identified each day at the airport. To insure 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 insure immediate corrective action is undertaken

    c. 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.

2. Construction Area Marking: Temporary lighting, barricades, flagging, and flashers are required as shown on the plans and per FAA AC 150/5370-2F Chapter 2 Section 220.b.(1)(2) Flag lines, traffic cones, flashers, edge lights, and/or signs shall be used as necessary:

    a. To clearly separate all construction from other parts of an air operations area
    b. To identify isolated hazards, such as open manholes, excavations, areas under repair, stockpiled material, waste areas, etc.
    c. Vehicle and pedestrian access routes used for airport construction shall be controlled to prevent any unauthorized entry of persons, vehicles, or animals.
    d. Vehicle parking areas for Contractor employees shall be designated in advance to minimize traffic in open/active aircraft movement areas.

3. Cables and Utilities:

    a. 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.

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b. 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.
c. 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.
d. 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 of utmost importance for both the scheduling of an outage and the removal of conductors while cutting the joint.

4. Vehicle and Employee Identification:

a. Contractor vehicles and equipment 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 150/5210-5D, current edition, or as outlined in Section 011430 "Vehicle and Equipment Permitting" of the Contract Documents.
b. 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.

5. Radio Communications:

a. The Contractor’s construction superintendent and flag 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 safely carried on at all times.

6. Haul Routes Crossing Active Aircraft Operation Areas:

a. 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 damage (FOD) or other objectionable debris that may result from hauling activities. Additional broom trucks may be required to

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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.

b. 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.
c. 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 150/5210-5D, current edition.
d. All Contractor and Subcontractor employees must be aware of the types of safety problems and hazards associated with aircraft operations and construction activities.

PART 3 - PRODUCTS

3.1 Contractor's Operational Safety Plan

A. The Contractor shall provide six (6) copies of the Contractor’s Operational Safety Plan to the DEN Project Manager for review at least ten (10) calendar days before on-site construction begins. The Contractor's program must meet, as a minimum, all applicable federal, state and local government requirements, and the following:

1. The Contractor shall provide the following information for acceptance by the DEN Project Manager prior to the commencement of construction activities. The Operational 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. 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.

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e. The Contractor shall show how material shall be stored beside the excavation. Stored material shall include the excavated and backfilled material
f. Injury and accident handling, including samples of the reporting form.
g. 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.
h. 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.
i. How and when all electric devices will be checked for proper grounding and insulation. Describe the methods that will be used to lock out electric systems that should not be energized.
j. How trash and human organic waste will be disposed of.
k. How snow and ice will be removed by the Contractor in the project area.
l. How concrete forms will be anchored to ensure their stability, including calculations showing that the forms will safely hold the maximum construction loads.
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 working above ground level will be protected from falling.
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. The type of personal protective equipment that will be used to protect personnel from hazards.
w. The type of safety training that will be provided to personnel to inform them of safe work procedures.
x. How daily audits and inspections will be performed to ensure compliance with the Contractor's Operational Safety Plan and current, applicable OSHA regulations.
y. 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.

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z. How compressed gases will be safely stored, handled, and used.
aa. 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.

bb. How the hazards of chemicals will be communicated to personnel, including the use of material safety data sheets and chemical labels.
cc. Methods to ensure that forklifts and other powered industrial trucks are operated in a safe manner.
dd. How an effective hearing conservation program will be used to protect personnel from high noise levels and prevent hearing loss.
ee. How personnel will be protected from the effects of jet blast.
ff. How hazards will be identified and corrected when reported.

3.2 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 Operational Safety Plan.

PART 4 - EXECUTION

4.1 IMPLEMENT CONTRACTOR'S OPERATIONAL SAFETY PLAN

A. Implement the approved Contractor's Operational Safety Plan as described in Part 1 and Part 2 of this Section and in Section 011100 "Summary of Work."

B. If the Contractor experiences lost time or an injury rate greater than 75 percent of the national average for all construction, the Contractor shall notify the DEN Project Manager, audit its safety procedures, and submit a plan to reduce its rates.

C. If at any time the lost time or injury rates experienced by the Contractor are 150 percent or more of the national average for construction, the Contractor shall notify the DEN Project Manager and immediately hire an independent safety professional who shall audit the Contractor's procedures and operations and make a report of changes that the Contractor should implement to reduce the rate including changing personnel.

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.

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4. Failure to comply with these requirements is a basis to withhold a portion of progress payments.

4.2 ROLLING OWNER CONTROLLED INSURANCE PROGRAM (ROCIP)

A. Implement Rolling Owner Controlled Insurance Program (ROCIP) as provided in the Project Manual issued for bid or proposal

4.3 OWNER CONTROLLED INSURANCE PROGRAM (OCIP)

A. Implement Owner Controlled Insurance Program (OCIP) as provided in the Project Manual issued for bid or proposal

PART 5 - MEASUREMENT

5.1 METHOD OF MEASUREMENT

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

PART 6 - PAYMENT

6.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section.

END OF SECTION **013520**

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SECTION 014100 - REGULATORY REQUIREMENTS

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 identifies primary compliance with the State, City and County of Denver's regulatory requirements including:

1. City and County of Denver / Department of Aviation.
2. Colorado Department of Public Health and Environment.
3. City and County of Denver Development Services, including the Department of Public Works and Division of Wastewater Management.
4. The standards that govern design and construction projects at Denver International Airport.

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.

1.3 RELATED SECTIONS

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

1.4 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.

1.5 DENVER BUILDING DEPARTMENT

A. For review and approval of all construction documents for compliance to the Denver

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building code:

1.6 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
745 West Colfax Avenue
Denver, Colorado 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. 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.

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

3.1 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.

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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

4.1 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.

END OF SECTION **014100**

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SECTION 014210 - REFERENCED MATERIAL

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 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.

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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 Building Information Modeling (BIM) 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

4.1 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.

END OF SECTION **014210**

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SECTION 014220 - ABBREVIATIONS AND SYMBOLS

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 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

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Abbreviation	Definition
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
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

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Abbreviation	Definition
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
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

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Abbreviation	Definition
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

4.1 METHOD OF MEASUREMENT

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

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PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section.

END OF SECTION **014220**

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SECTION 014225 - REFERENCE STANDARDS

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 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.

1.3 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

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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

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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

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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).

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PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION (Not used)

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.

END OF SECTION **014225**

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SECTION 014230 - DEFINITIONS AND CONVENTIONS

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 contains a list of definitions of words or phrases and grammatical or contextual conventions commonly used in these Contract Documents.

1.3 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.

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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.

1.4 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.

1.5 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.

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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.

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

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.

END OF SECTION **014230**

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SECTION 014310 -DEN QUALITY ASSURANCE

Per the DEN Technical Specification Committee, this section is deleted from the DEN Technical Specification Library.

This Section has no Section Text.

PART 1 - GENERAL (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION **014310**

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SECTION 014510 - CONTRACTOR QUALITY CONTROL

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 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 assure 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 its consultant working as the City agent 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 agents’ inspectors and testers to perform these tests and inspections. 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.

1.3 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

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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

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the production staff with clear lines of authority for Quality Control.

5. The City and/or the City Program Management Team acting as the City agent will 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's agency, 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 inspector 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

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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 work day:

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.

1.4 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 quality related 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 three (3) 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,

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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.

1.5 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.

1.6 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

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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

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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.

1.7 CONTRACTOR SUBMITTAL OF PROPOSED CONTRACTOR’S TESTING AGENCIES

A. Refer to Section 014525 - Material Testing Agency

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PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 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.

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.

B. Refer to Article 1706 - Removal of Defective Materials and Work in the General Contract Conditions, 2011 Edition.

END OF SECTION **014510**

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SECTION 014525 - MATERIAL TESTING AGENCY

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. 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.

1.3 SUBMITTALS

A. All submittals shall comply with requirements of Sections 013300 "Submittal

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Procedures" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal requirements.

1.4 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 programs.
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.

1.5 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

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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.

1.6 WEEKLY SUMMARY REPORTS

A. The CTA and Quality Control Manager shall prepare and submit to the DEN Project

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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 013000 and 013350 requirements.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 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 by such actions.

3.2 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 CTA or such personnel at no cost to DEN.

3.3 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.

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PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section.

B. Refer to Title 17 - Inspection and Defects of the General Contract Conditions, 2011 Edition, for guidance on payment methods.

END OF SECTION **014525**

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SECTION 014545 - SPECIAL INSPECTION AGENCY AND OWNER TESTING AGENCIES

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.

B. Special Inspection Statement issued as part of the application for building permit for the specific task or project.

1.2 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 Special Inspection Agency 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 the requirement of special inspection or require 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, 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

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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.

1.3 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.

1.4 CONTRACTOR SUBMITTAL OF PROPOSED CONTRACTOR’S TESTING AGENCIES

A. Projects requiring Special Inspection where the Contractor is utilizing 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

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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 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 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.

1.5 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

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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.

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1.6 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

3.1 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 by such actions.

3.2 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.

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3.3 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

4.1 METHOD OF MEASUREMENT

A. No separate measurement shall be made for Work under the Section. DEN Project Management Team staff will track all costs and remark the conditions and track all associated impacts for credits to the City. The contractor record of the same is only valid if signed by the DEN Project Manager or authorized representative.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for Work under this Section.

B. Refer to Title 17 - Inspection and Defects in the General Contract Conditions, 2011 Edition, for guidance on payment methods.

END OF SECTION 014545

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SECTION 015050 - MOBILIZATION

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.

B. Section 012910 "Schedule of Values”

1.2 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.

1.3 SUBMITTALS

A. Refer to Section 013300 "Submittal Procedures" and Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.

B. Submit a Mobilization Schedule a minimum of fourteen (14) days prior to first billing for mobilization.

1.4 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

2.1 PRODUCTS

A. Provide construction tools, equipment, materials, and supplies of the type and quantities that will facilitate the timely execution of the Work.

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PART 3 - EXECUTION

3.1 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.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

A. Refer to Section 013210 - Schedule, for details regarding mobilization scheduling, billing, and payment.

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. Refer to Article 1104 - Changes in the Work, Contract Price or Contract Time of the General Contract Conditions, 2011 Edition.

END OF SECTION **015050**

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SECTION 015210 - TEMPORARY FACILITIES

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. 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.

1.3 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 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.
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

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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 their 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)**] [**<specify number>**] people with the currently approved schedule posted on a wall. The conference room shall have [**network connection with a monitor**] and [**one (1)**] [**<insert number>**] available telephone.
    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)**] [**<insert number>**] 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:

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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 at least two (2) telephones in the Contractor's main field office. These phones shall be manned at all times by the Contractor's personnel or by an answering machine when personnel are not in the field office.
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

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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.

1.4 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.

1.5 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

2.1 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.

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2.2 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.

2.3 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.

2.4 FIRE PROTECTION

A. Fire extinguishers shall be UL rated and shall comply with the International Fire Code with City of Denver amendments.

2.5 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

3.1 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.

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B. Comply with requirements of Division 26 Sections.

3.2 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.

3.3 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.

3.4 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.

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3.5 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.

3.6 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.

3.7 SIGNAGE

A. Contractor shall not provide any signage for temporary facilities without prior approval from the DEN Project Manager.

3.8 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

4.1 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.

END OF SECTION 015210

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SECTION 015215 - FIELD OFFICES

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. 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

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 PAYMENT

A. No separate payment will be made for work under this Section.

END OF SECTION **015215**

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SECTION 015525 - TRAFFIC CONTROL

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. 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, 2011 Edition.

1.3 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.

1.4 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

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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

2.1 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

3.1 TEMPORARY TRAFFIC CONTROL DEVICES

A. Place temporary control devices in a manner that allows for the smooth flow of traffic at the posted speed limit, limiting hazards or abrupt changes in direction.

B. Place traffic cones or delineators as directed by the MUTCD. Operate warning lights between sunset and sunrise.

C. Place control devices so that approaching traffic is alerted to hazards and variances to normal traffic patterns.

D. Clean and repair damaged devices or replace them with new devices as required.

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3.2 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.

3.3 FLAGGERS

A. Furnish flaggers where required for safety and by the MHT.

3.4 CONSTRUCTION VEHICULAR TRAFFIC

A. Restrict construction vehicles to approved haul routes.

B. Haul routes on the airfield must be approved by Security.

3.5 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, 2011 Edition.

3.6 SIGNS

A. Refer to Title 8, Article 802 - Protective Devices and Safety Precautions in the General Contract Conditions, 2011 Edition.

1. The Contractor must contact the DEN Project Manager a minimum of five (5) working days in advance of construction for installation, relocation, or removal of regulatory parking signs.

B. Coordinate and pay any expense associated with the furnishing and installation of all parking regulatory signs, such as "No Stopping Any Time," etc., at the work site.

C. Furnish and install any necessary advance detour or guidance signing.

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

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

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PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 PAYMENT

A. Payment for Traffic Control under these schedules will be for work performed under the applicable unit price item or lump sum bid item.

END OF SECTION 015525

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SECTION 015719 - TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 - GENERAL

1.1 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)

1.2 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 permitee, and all inspection requirements have been satisfied in accordance with State and local permitting requirements.

1.3 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:

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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”

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means “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 ISDS permit issued by the Denver Department of Environmental Health.

3. Submittals pertaining to air quality management:

1) 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.

1.4 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.

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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 - Greenprint Denver Office and Sustainability Policy.
3. Denver Revised Municipal Code, Title II, Sections 48-44 and 48-93 - Solid Waste.

D. City and County of Denver Construction Sites Program.

E. City and County of Denver Construction Activities Stormwater Management Plans Information Guide.

F. Any other applicable rules, regulations, ordinances, and guidance must be followed as applicable.

G. Refer to Section 013300 "Submittal Procedures" and 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.

H. Refer to Section 017419 "Construction Waste Management" for waste management requirements

PART 2 - PRODUCTS

2.1 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 "Urban Drainage and Flood Control District’s Urban Storm Drainage Criteria Manual, Volume 3: Best Management Practices".

PART 3 - EXECUTION

3.1 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.

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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.

3.2 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. Refer to Section 264200 "Cathodic Protection" for cathodic protection requirements.
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.

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3.3 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 Sites Program, 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.

3.4 CONSTRUCTION OF CONTROL MEASURES FOR EROSION AND SEDIMENTATION

A. The Contractor must install control measures in accordance with the most recent version of the "Urban Drainage and Flood Control 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 NPDES Inspector.

3.5 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:

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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.

3.6 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.

3.7 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

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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.

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.

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

END OF SECTION 015719

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SECTION 015810 - TEMPORARY SIGNS

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. 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.

1.3 SUBMITTALS

A. Submit temporary sign finishes, materials and paint, etc., for review and approval by DEN Project Manager prior to any fabrication.

1.4 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

2.1 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.

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C. Exterior signs must be vandal-proof and fabricated of weatherproof materials.

PART 3 - EXECUTION

3.1 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.

3.2 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.

3.3 MAINTENANCE

A. The Contractor shall maintain temporary signage until it is no longer needed, as determined by DEN Project Manager.

3.4 REMOVAL

A. The Contractor shall remove all temporary signs, and clean and refurbish affected areas to their original, or intended, condition.

PART 4 - MEASUREMENT

4.1 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.

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SECTION 016000 - PRODUCT REQUIREMENTS

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. 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.

1.3 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.

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1.4 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.

1.5 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.

1.6 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

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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 Project 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.

1.7 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

2.1 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.

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6. Or Equal: For products specified by name and accompanied by the term "or equal," or "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
2. Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
3. Products:

    a. Restricted List: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered[unless otherwise indicated.
    b. Nonrestricted List: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.

4. Manufacturers:

    a. Restricted List: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will 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.

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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.

2.2 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.

2.3 MATERIALS

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

1. For projects requiring compliance with sustainable design and construction practices and procedures, 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.

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PART 3 - EXECUTION (Not Used)

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.

END OF SECTION **016000**

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SECTION 016610 - STORAGE AND PROTECTION

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. 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:

1. Section 015210 "Temporary Facilities" for requirements for temporary facilities.

1.3 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

2.1 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.

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PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS OF EXECUTION

A. Palletize materials, products, and supplies that are to be incorporated into the construction and 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 which will 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.

3.2 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.

3.3 STORAGE

A. Store items in a manner that shall prevent damage to the DEN's property. Do not store

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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.

3.4 LABELS

A. Storage cabinets and sheds that will contain flammable substances and explosive substances shall be labeled "FLAMMABLE - KEEP FIRE AWAY" and "NO SMOKING" with conspicuous, bold lettering and conforming to OSHA requirements. Flammable substances shall be stored in flammable storage cabinets that conform to OSHA requirements.

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. The cost of the Work described in this Section shall be included in the applicable unit

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price item, work order, or lump sum bid item.

B. Reference Section 012910 "Schedule of Values" for additional requirements for the possible payment of stored material.

END OF SECTION 016610

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SECTION 017300 - EXECUTION

Per the DEN Technical Specification Committee, this section is deleted from the DEN Technical Specification Library.

This Section has no Section Text. The EXECUTION information that was previously provided in this Section is now included in PART 3 – EXECUTION of each previously referenced Section.

PART 1 - GENERAL (Not Applicable)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION **017300**

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SECTION 017330 - CUTTING AND PATCHING

PART 1 - GENERAL

A. RELATED DOCUMENTS

B. Drawings and general provisions of the Contract, including General and Special Conditions and other Division 01 Specification Sections, apply to this Section.

C. Refer to Article 316, Cutting and Patching the Work in the General Contract Conditions, 2011 Edition

1.2 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.

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1.3 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.

1.4 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 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. 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.

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1.5 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.

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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.

1.6 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.

1.7 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.

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PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 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.

3.2 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.

3.3 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.

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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.

3.4 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.

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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.

3.5 CORE DRILLING

A. The Contractor shall execute a minimum of 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

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to secure the areas affected by x-ray activities.

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.

END OF SECTION 017330

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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 both LEED and non-LEED projects. Note that LEED projects may have more specific requirements than identified in this section.

B. Waste materials shall be managed in accordance with all local, state, and federal regulations.

C. Related Requirements:

1. Section 013300 "Submittal Procedures" for submittal procedures.
2. Section 013325 "Shop and Working Drawings, Product Data and Samples" for submittal procedures.
3. Section 015719 "Temporary Environmental Controls" for environmental control procedures.
4. Section 018113 "Sustainable LEED Requirements" for LEED requirements.
5. Section 024116 "Structure Demolition" for disposition of waste resulting from demolition of buildings, structures, and site improvements[, and for disposition of hazardous waste].
6. Section 024119 "Selective Structure Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements[, and for disposition of hazardous waste].
7. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.
8. Section 311000 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.3 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

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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. The Contractor shall submit a list of materials and products used with Safety Data Sheets (SDS). Examples include chemicals, solvents, fuels, building materials, etc.

1. A hardcopy or electronic link to the SDS for all materials and products used, if applicable.
2. Identify storage methods for materials, including measures to segregate incompatible materials.

B. The Contractor shall submit a Waste Management Plan to the DEN Project Manager and DEN Environmental Services. Minimum Waste Management Plan requirements

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include the following:

1. A list of all waste streams generated by the project

    a. For each waste stream listed, the Contractor shall identify the handling/transportation method, the disposal method, and the disposal facility utilized.
    b. If the Contractor anticipates generation of hazardous waste, the Contractor shall provide its USEPA (generator) identification number.

2. Pollution Prevention Measures

    a. Describe best practices that will reduce waste. For example, waste reduction measures, requiring vendors to deliver materials in reusable packaging, etc.

3. Waste Management Plan Training.
4. Storage of materials.
5. Spill response.

C. Approval of Contractor's Waste Management Plan does not relieve the contractor of responsibility for compliance with applicable environmental regulations.

1. The contractor shall maintain a record of the amounts of construction and demolition waste generated, recycled, reused, salvaged, or disposed of, in pounds for review.
2. Hauling manifest records shall be maintained and available for review. Manifest forms are available from the DEN Project Manager

PART 2 - PRODUCTS

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

A. A hardcopy or electronic link to SDSs for all materials and products used.

B. Identify storage methods, including measures to segregate incompatible materials.

C. Refer to the Waste Management Plan

PART 3 - EXECUTION

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

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of Jackson Gap Street. The North Yard is located on the south side of 110th, west of Queensburg Street.

C. Concrete washwater cannot be discharged to surface waters or to storm sewer systems. Colorado Discharge Permit System (CDPS) coverage conditionally authorizes discharges to the ground of concrete wash water from washing of tools and concrete mixer chutes when appropriate best management practices (BMPs) are implemented.

1. A bermed containment area that allows discharge water to infiltrate or evaporate;

    a. Alternatives to bermed containment areas include portable concrete washout bins, and industrial washout containment systems where the accumulated waste is removed from the site and disposed of properly.

2. Use of the washout site should be temporary (less than one year);
3. The washout site should not be located in an area where shallow groundwater may be present, such as near natural drainages, springs, or wetlands
4. Upon termination of the washout site, accumulated solid waste, which includes concrete waste and contaminated soils, must be removed from the site and disposed of properly.

D. Rejected loads and/or other wet concrete or asphalt materials are PROHIBITED TO BE PLACED ANYWHERE on DEN property. These materials must be returned to the facility of origination or other permitted facility for proper disposal.

E. Concrete saw cutting slurry must be properly contained and disposed of.

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

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.

END OF SECTION 017419

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SECTION 017420 - CLEANING

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. 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

1.3 JOB CONDITIONS

A. Safety 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. Inspect those facilities regularly for hazardous conditions caused by construction activities.

B. Hazards Control:

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.

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C. Access:

1. Maintain the work site to permit access by other City contractors as required and to allow access by emergency personnel.

1.4 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

2.1 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.

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PART 3 - EXECUTION

3.1 INTERIM CLEANING

A. Clean the work site every shift/workday for the duration of the construction Contract. 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. All hard concrete, steel, wood, and finished walking surfaces shall be swept clean daily.

B. 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.

C. Sprinkle waste materials with water or acceptable chemical palliative to prevent blowing of dust.

D. Promptly empty waste containers when they become full and legally dispose of the contents at dumping areas off the City's property.

E. Control the handling of waste materials. Do not permit materials to be dropped or thrown from structures.

F. 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.

G. Clean only when dust and other contaminants will not precipitate upon newly painted surfaces.

H. Cleaning shall be done in accordance with manufacturer's recommendation.

I. Cleaning shall be done in a manner and using such materials as to not damage the Work.

J. Clean areas prior to painting or applying adhesive.

K. 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.

L. Clean all areas that will be concealed prior to concealment.

M. Dispose of all fluids according to the approved Washing Plan.

3.2 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:

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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

4.1 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.

END OF SECTION **017420**

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SECTION 017515 - SYSTEM STARTUP, TESTING AND TRAINING

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. Provide complete startup, testing, and operator training services to ensure operability of all systems supplied.

B. Coordinate all start-up and testing with DEN Commissioning Authority or DEN Asset Management through the DEN Project Manager.

1.3 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] [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.

1.4 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.

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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 8k with a minimum framerate of 60Hz

D. Preinstruction 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.

1.5 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

3.1 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

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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 six (6) 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

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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.

3.2 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.

3.3 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).

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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

4.1 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.

B. No contractual item requiring startup or testing will be paid until the conditions of this Section are completely satisfied.

END OF SECTION 017515

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SECTION 017720 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 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.

1.2 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

3.1 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.

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3.2 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.

3.3 REINSPECTION FEES

A. Should the DEN Project Manager be required to perform re-inspections of the Work due to the Contractor prematurely claiming the status of the Work to be complete:

1. The Contractor shall compensate the City for such additional services at the rate of $125.00 per man-hour, with a minimum charge of $250.00.
2. The City shall deduct the amount of such compensation from the final payment to the Contractor.

3.4 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

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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.

3.5 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.

1. Fees at the rate of $450 per day.
2. The resubmittal of required documents may extend the 100-day time frame at the DEN Project Manager's discretion.

3.6 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

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issued Change Orders.

3.7 FINAL APPLICATION FOR PAYMENT

A. The Contractor shall submit the final application for payment in accordance with the procedures and requirements detailed in Article 2003, Final Settlement in the General Contract Conditions, 2011 Edition.

PART 4 - MEASUREMENT

4.1 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.

END OF SECTION 017720

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SECTION 017825 - OPERATION AND MAINTENANCE DATA

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. 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.

1.3 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] [90] 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 commissioning 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.

1.4 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, as it becomes available.

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PART 2 - PRODUCTS

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

3.1 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.

3.2 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.

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3.3 CONTENTS OF THE MANUAL

1. Table of Contents, which references, at a minimum, three heading levels.
2. Index of Equipment/Data with entries for equipment type and MasterFormat Division and Section.
3. A Master Index that contains index entries for all submitted Operation and Maintenance Data Manuals.

    a. Equipment/Data shall be indexed by equipment type and MasterFormat Division and Section.

4. Name, address, and telephone numbers of Contractor, suppliers and installers along with the manufacturer's order number and description of the order.
5. Name, address, and telephone numbers of manufacturer's nearest service representatives.
6. Name, address, and telephone number of nearest parts vendor and service agency.
7. Copy of guaranties and warranties issued to, and executed in the name of, the City.
8. Anticipated date the City assumes responsibility for maintenance.
9. Description of system and component parts including theory of operation.
10. Pre operation check or inspection list.
11. Procedures for starting, operating, and stopping equipment.
12. Post operation check or shutdown list.
13. Inspection and adjustment procedures.
14. Troubleshooting and fault isolation procedures for on-site level of repair.
15. Emergency operating instructions.
16. Accepted test data.
17. Maintenance schedules and procedures.
18. Test procedures to verify the adequacy of repairs.
19. One (1) copy of each wiring diagram.
20. One (1) copy of each piping diagram.
21. Location where all measurements are to be made.
22. One (1) copy of each duct diagram.
23. One (1) copy of control diagram.
24. One (1) copy of each accepted shop drawing.
25. One (1) copy of software programs imputable or changeable on site.
26. Ordering information.
27. Training course material used to train DEN staff, including slides and other presentation material.
28. 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

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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

4.1 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.

END OF SECTION 017825

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SECTION 017835 - WARRANTIES AND BONDS

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. The Work specified in this Section consists of preparing and submitting warranties and bonds required by the Contract and these Specifications.

1.3 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 specifically to the City.
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

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PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 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

4.1 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.

END OF SECTION 017835

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SECTION 017840 - CONTRACT RECORD DOCUMENTS

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. The Work specified in this Section consists of maintaining, marking, recording, and submitting Contract record documents that include shop drawings, warranties, Contract Documents, and contractor records.

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".

1.3 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.

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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.

1.4 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

3.1 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:

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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.

3.2 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.

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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.

3.3 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.

3.4 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.

B. If, during the inspection, the DEN Project Manager determines that the documents are not being maintained and kept current as to 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 and recording the as-built Contract data. This cost will be determined based on $100.00 per man-hour of effort.

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.

END OF SECTION 017840

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SECTION 017900 - DEMONSTRATION AND TRAINING

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. 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.

1.3 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**] [**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.

1.4 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit [**two (2)**] <**Insert number**> copies within [**seven (7)**] <**Insert number**> days of end of each training module.

1. Identification: On each copy, provide an applied label with the following information:

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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 [**prepared and bound in format matching operation and maintenance manuals**] [**in PDF electronic file format**] **[preapproved electronic media**].

1.5 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. Preinstruction 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.

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1.6 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

2.1 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.

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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.

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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

3.1 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.

3.2 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)**] <**Insert number**> 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 [**an oral**] [**a written**] [**a demonstration**] performance-based test.

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F. Cleanup: Collect used and leftover educational materials and [**remove from Project site**] [**give to City**]. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

3.3 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**] [**by posting to Web-based photographic documentation service provider's Web site**]. Recordings shall be high-resolution [**720p**] [**1080p**][**4k**][**8k**] with a minimum framerate of 60Hz

1. File Names: Utilize file names based upon name of equipment generally described in video segment, as identified in Project specifications.
2. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the Equipment Demonstration and Training DVD that describes the following for each Contractor involved on the Project:

a. Name of Contractor/Installer.
b. Business address.
c. Business phone number.
d. Point of contact.
e. E-mail address.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.

1. Film training session(s) in segments not to exceed 15 minutes.

a. Produce segments to present a single significant piece of equipment per segment.
b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.

1. Furnish additional portable lighting as required.

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E. Narration: Describe scenes on video recording by [**audio narration by microphone while**] [**dubbing audio narration off-site after**] 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

4.1 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.

END OF SECTION 017900

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SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

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.

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

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34. Section 260548 – Vibration and Seismic Controls for Electrical Systems

1.2 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.

1.3 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.

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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

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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.

1.4 ACTION SUBMITTAL*S*

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.

1.5 INFORMATIONAL SUBMITTALS

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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.

1.6 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 [**each**]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.

1.7 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.

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1.8 [**EACH**]CONTRACTOR'S RESPONSIBILITIES

A. [**Each**]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.

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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

1.9 CxA'S RESPONSIBILITIES

A. Organize and lead the commissioning team through the entire project.

B. Provide and updatedesign phase and 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.

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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

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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

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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 completeper 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

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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

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failure, freeze conditions, no flow, equipment failure, etc.

B. Development of Test Procedures

1. CxA shall develop specific and customtest 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.

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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.

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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.

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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

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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,

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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

4.1 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. .

END OF SECTION 019113

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SECTION 019990 - STANDARD FORMS

Per the DEN Technical Specification Committee, this section is deleted from the DEN Technical Specification Library.

Please refer to the individual Sections for form information.

END OF SECTION 019990

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SECTION 024119 - SELECTIVE DEMOLITION

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. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements.
3. Salvage of existing items to be reused or recycled.
4. Repair procedures for selective demolition operations.

B. Related Requirements:

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain DIA’s property, demolished materials shall become the Contractor's property and shall be removed from the Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Proposed Protection Measures: Submit report, including drawings, that indicates

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the measures proposed for protecting individuals and property , for environmental protection , for dust control and , for noise control, and proposed time frame for their operation. Identify options if proposed measures are later determined to be inadequate. Indicate proposed locations and construction of barriers.

B. Submit Schedule of Selective Demolition Activities. Indicate the Following:
   1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's DIA's and other tenant's on-site operations are uninterrupted.
   2. Interruption of utility services. Indicate how long utility services will be interrupted.
   3. Do not interrupt utility services without prior written request and approval from DIA Project Manager and authorities having jurisdiction.
   4. Coordination for shutoff, capping, and continuation of utility services.
   5. Use of elevator and stairs.
   6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

C. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

D. Predemolition Photographs or Video: Submit before Work begins.

E. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

1.6 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI A10.6 and NFPA 241.

1.8 FIELD CONDITIONS

A. When there are occupied portions of buildings immediately adjacent to selective demolition area, conduct selective demolition so DIA’s or tenant’s operations will not be disrupted.

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1. Provide not less than 72 hours' notice to DIA Project Manager of activities that will affect DIA's or tenant's operations.

B. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from authorities having jurisdiction.

C. DIA assumes no responsibility for condition of areas to be selectively demolished. DIA will maintain conditions existing at time of inspection for bidding purpose as far as practical.

D. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
1. Before selective demolition, Owner will remove the following items:

a. <**Insert items to be removed by Owner**>.

E. Notify DIA Project Manager of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

F. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
1. Hazardous materials will be removed by Owner before start of the Work.
2. If suspected hazardous materials are encountered, do not disturb; immediately notify DIA Project Manager. Hazardous materials will be removed by Owner under a separate contract.

G. Storage or sale of removed items or materials on-site is not permitted.

H. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
1. Maintain fire-protection facilities in service during selective demolition operations.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

A. Use repair materials identical to existing materials.

B. If identical materials are unavailable or cannot be used for exposed surfaces, use materials that, when installed, will match the visual and functional performance of existing materials, as approved by DIA Project Manager.

C. Use materials whose installed performance equal or surpass that of existing materials.

D. Comply with material and installation requirements specified in individual specification sections.

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2.2 PEFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

D. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.

E. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to DIA Project Manager.

F. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.
   1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

G. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.
   1. Comply with requirements specified in Section 013233 "Photographic Documentation."
   2. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to

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remain and protect them against damage.

1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."
2. Do not interrupt existing utilities serving occupied or operating facilities unless authorized in writing by the DIA Project Manager and authorities having jurisdiction.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Arrange to shut off indicated utilities and obtain prior written approval with DIA Project Manager and utility companies.
2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

Equipment to Be Removed: Disconnect and cap services and remove equipment.

Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

3.3 PREPARATION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Do not close or obstruct roads, streets, walks, walkways, or other adjacent occupied or used facilities without written authorization from the DIA Project Manager and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
2. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.

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3. Protect existing site improvements, appurtenances and landscaping.
4. Erect a plainly visible fence around drip lines of individual trees or around perimeter drip lines of groups of trees.

B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
1. Strengthen or add new supports when required during progress of selective demolition.

D. Temporary Enclosures: Provide temporary enclosures for protection of existing buildings and construction projects, both in progress and completed, from exposure, foul weather and other construction operations. Provide temporary weather tight enclosures for building exteriors.
1. Where heating or cooling is needed and permanent enclosures are not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
2. Contractor shall be responsible for any damage to existing conditions due to inadequate temporary enclosures or due to failure of temporary enclosures.

E. Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.

3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

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1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

B. Removed and Salvaged Items:
   1. Clean salvaged items.
   2. Pack or crate items after cleaning. Identify contents of containers.
   3. Store items in a secure area until delivery to DIA.
   4. Transport items to DIA's storage area as designated by the DIA Project Manager.
   5. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:
   1. Clean and repair items to functional condition adequate for intended reuse.
   2. Paint equipment to match new equipment, with coatings of equal color, finish and performance of new equipment.
   3. Pack or crate items after cleaning and repairing. Identify contents of containers.
   4. Protect items from damage during transport and storage.
   5. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

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D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by DIA Project Manager, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 PATCHING AND REPAIRS

A. General: Promptly repair damage to adjacent construction caused by selective demolition operations.

B. Patching: Comply with Specification Section 017330 "Cutting and Patching".

C. Repairs: Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
   1. Completely fill holes and depressions in existing masonry walls that are to remain with an approved masonry patching material applied according to manufacturer's written recommendations.

D. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

E. Floors and Walls: Where walls or partitions that are demolished 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.
   1. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements as specified in other sections of these specifications.
   2. Where patching occurs on a painted surface, apply primer and intermediate paint coats over the patch and apply a final paint coat over the entire unbroken surface containing the patch. Provide additional coats until the patch blends with adjacent surfaces.
   3. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

F. Ceilings: Patch, repair or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between

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saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

D. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be **recycled,** reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
   1. Do not allow demolished materials to accumulate on-site.
   2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
   3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
   4. Disposal shall be in accordance with Division 32 requirements.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.8 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.9 SELECTIVE DEMOLITION SCHEDULE

A. Existing Items Construction to Be Removed: <**Insert description of items and construction to be removed**>.

B. Existing Items to Be Removed and Salvaged: <**Insert description of items to be removed and salvaged**>.

C. Existing Items to Be Removed and Reinstalled: <**Insert description of items to be removed and reinstalled**>.

D. Existing Items to Remain: <**Insert description of items to remain**>.

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PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 024119

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SECTION 033000 - CAST-IN-PLACE CONCRETE

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 cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
   1. Slabs-on-grade.
   2. Suspended slabs.
   3. Concrete toppings.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

   1. Include data substantiating that materials comply with requirements.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments. Concrete materials representing current production shall be tested and used to fabricate trial mix data. The testing lab shall submit and certify the results of all tests and/or certificates of all materials and calculations used to develop the 7-day and 28-day compressive strength test results and applicable reference specifications.

   1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement according to ACI 315 "Details and Detailing of Concrete Reinforcement". Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

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Include special reinforcement required for openings through concrete structures.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. Design and engineering of formwork are Contractor's responsibility.
2. Submit shop drawings showing all formwork and sequencing of all vertical concrete walls 8 feet or more in height. Coordinate pour breaks in architectural exposed exterior concrete walls so that pour breaks occur at the top or bottom of a reveal. Show form tie locations. Provide uniform form tie spacing at architecturally exposed exterior concrete walls.
3. Shop drawings to be prepared by a Colorado Professional Engineer.

4. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the DEN Project Manager. Do not proceed with work unless construction joint shop drawings are approved by Owner.

F. Samples: For [**waterstops**]

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For [**Installer**] [**manufacturer**]

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Semirigid joint filler.
13. Joint-filler strips.
14. Repair materials.
15. Structural epoxy for reinforcing.

D. Material Test Reports: For the following, from a qualified testing agency, indicating

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compliance with requirements:

1. Aggregates.[**Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.**]

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Field quality-control reports.

G. Minutes of preinstallation conference.

1.6 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those per-formed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.

C. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

D. Testing Agency Qualifications: An independent testing agency, acceptable to the DEN Project Manager and the City of Denver, and all authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

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E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

F. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

G. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," [**Sections 1 through 5.**]
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

H. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

I. Preinstallation Conference: Conduct conference at **location and time as determined by DEN Project Manager**.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete subcontractor.
e. Special concrete finish subcontractor.

2. Review [**special inspection and testing and inspecting agency procedures for field quality control,**] [**concrete finishes and finishing,**] [**cold- and hot-weather concreting procedures,**] [**curing procedures,**] [**construction contraction and isolation joints, and joint-filler strips,**] [**semirigid joint fillers,**] [**forms and form removal limitations,**] [**shoring and reshoring procedures,**] [**steel reinforcement installation,**] [**floor and slab flatness and levelness measurement,**] [**concrete repair procedures,**] and concrete protection.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damageStore reinforcement above the ground on platforms, skids or other supports.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

C. Avoid damaging coatings on steel reinforcement.

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D. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963/D 3963M.

E. Damaged or non-conforming materials shall be removed from the Project Site and replaced with new satisfactory materials at no additional cost to Owner.

F. Deliver packaged materials to Project Site in original, unopened, and undamaged containers plainly labeled with manufacturer's name, product name and designation, expiration period for use, mixing instructions for multi-component materials and other pertinent data. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breakage, and other causes.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

    a. High-density overlay, Class 1 or better.
    b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    c. Structural 1, B-B or better; mill oiled and edge sealed.
    d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

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G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than [**25**] [**60**] percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

D. Steel Bar Mats: ASTM A 184/A 184M, fabricated from [**ASTM A 615/A 615M,** Grade 60 (Grade 420)].

E. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

F. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-

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steel bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150 [**Type I/II**] [**gray**] **Supplement with the following:**]

   a. Fly Ash: ASTM C 618, [**Class F**]
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, [**Class 3S**] coarse aggregate or better, graded. Provide aggregates from a single source[**with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials**].

1. Maximum Coarse-Aggregate Size: [**3/4 inch** (19 mm)] nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Combined Aggregate Gradation: Well graded from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 sieve, and less than 8 percent may be retained on sieves finer than No. 50.

C. Water: ASTM C 94/C 94M **and potable**.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

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1. Products: Subject to compliance with requirements, provide one of the following:

    a. Axim Italcementi Group, Inc.; CATEXOL CN-CI.
    b. BASF Construction Chemicals - Building Systems; Rheocrete CNI.
    c. Euclid Chemical Company (The), an RPM company; [**ARRMATECT**] [**EUCON BCN**] [**EUCON CIA**].
    d. Grace Construction Products, W. R. Grace & Co.; DCI.
    e. Sika Corporation; Sika CNI.
    f.
    g. or approved equal.

D. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. BASF Construction Chemicals - Building Systems; Rheocrete 222+.
    b. Cortec Corporation; MCI- [**2000**] [**2005NS**].
    c. Grace Construction Products, W. R. Grace & Co.; DCI-S.
    d. Sika Corporation; FerroGard 901.
    e.
    f. or approved equal.

E.

2.6 WATERSTOPS

1.

2.

B. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Carlisle Coatings & Waterproofing, Inc.; MiraSTOP.
    b. CETCO; Volclay Waterstop-RX.
    c. Concrete Sealants Inc.; Conseal CS-231.
    d. Greenstreak; Swellstop.
    e. Henry Company, Sealants Division; Hydro-Flex.
    f. JP Specialties, Inc.; Earth Shield Type 20.
    g. or approved equal.

2. :

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2.7 LIQUID FLOOR TREATMENTS

A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ChemMasters; Chemisil Plus.
b. ChemTec Int'l; ChemTec One.
c. Conspec by Dayton Superior; Intraseal.
d. Curecrete Distribution Inc.; Ashford Formula.
e. Dayton Superior Corporation; Day-Chem Sure Hard (J-17).
f. Edoco by Dayton Superior; Titan Hard.
g. Euclid Chemical Company (The), an RPM company; Euco Diamond Hard.
h. Kaufman Products, Inc.; SureHard.
i. L&M Construction Chemicals, Inc.; Seal Hard.
j. Meadows, W. R., Inc.; LIQUI-HARD.
k. Metalcrete Industries; Floorsaver.
l. Nox-Crete Products Group; Duro-Nox.
m. Symons by Dayton Superior; Buff Hard.
n. US SPEC, Division of US Mix Products Company; US SPEC Industraseal.
o. Vexcon Chemicals, Inc.; Vexcon StarSeal PS Clear.
p. or approved equal.

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
b. BASF Construction Chemicals - Building Systems; Confilm.
c. ChemMasters; SprayFilm.
d. Conspec by Dayton Superior; Aquafilm.
e. Dayton Superior Corporation; Sure Film (J-74).
f. Edoco by Dayton Superior; BurkeFilm.
g. Euclid Chemical Company (The), an RPM company; Eucobar.
h. Kaufman Products, Inc.; Vapor-Aid.
i. Lambert Corporation; LAMBCO Skin.
j. L&M Construction Chemicals, Inc.; E-CON.
k. Meadows, W. R., Inc.; EVAPRE.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group; MONOFILM.
n. Sika Corporation; SikaFilm.
o. SpecChem, LLC; Spec Film.

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p. Symons by Dayton Superior; Finishing Aid.
q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
r. Unitex; PRO-FILM.
s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.
t. or approved equal.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. BASF Construction Chemicals - Building Systems; Kure 200.
c. ChemMasters; Safe-Cure Clear.
d. Conspec by Dayton Superior; W.B. Resin Cure.
e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
f. Edoco by Dayton Superior; Res X Cure WB.
g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
h. Kaufman Products, Inc.; Thinfilm 420.
i. Lambert Corporation; AQUA KURE - CLEAR.
j. L&M Construction Chemicals, Inc.; L&M Cure R.
k. Meadows, W. R., Inc.; 1100-CLEAR.
l. Nox-Crete Products Group; Resin Cure E.
m. Right Pointe; Clear Water Resin.
n. SpecChem, LLC; Spec Rez Clear.
o. Symons by Dayton Superior; Resi-Chem Clear.
p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.
r. or approved equal.

2.9 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: [**ASTM D 1751, asphalt-saturated cellulosic fiber**].

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, [**epoxy resin with a Type A shore durometer hardness of 80**] per ASTM D 2240.

C. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion, or styrene butadiene.

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D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. [**Types I and II, non-load bearing**] for bonding hardened or freshly mixed concrete to hardened concrete.

E. Reglets: Fabricate reglets of not less than 0.022-inch- (0.55-mm-) thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.10 REPAIR MATERIALS

A. 5000 psi (34.5 MPa)Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than [**5000 psi (34.5 MPa)**] at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials:[**Use fly ash, pozzolan, as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 40 percent.**] [**Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:**]

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to [**0.15**] percent by weight of cement.

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D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use [**water-reducing**] [**high-range water-reducing**] [**or**] [**plasticizing**] admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

1.

B. Suspended Slabs: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength [**4500 psi** (**31 MPa**)] at 28 days.
2. Maximum Water Cementitious Materials Ratio: .045
3. Slump Limit: [**5 inches** (**125 mm**)], plus or minus 1 inch (25 mm).
4. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.13 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).

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3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. [**Class A,** 1/8 inch (3.2 mm)] for smooth-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. **Chamfer** exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

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K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for [**24**] hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved[**at least 70 percent of**] its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by DEN Project Manager.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

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B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

G. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated, and as approved by DEN Project Manager. Coordinate locations of all construction joints with flooring materials, and review with DEN Project Manager.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
5. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

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3.6 WATERSTOPS

A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.7 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by DEN Project Manager.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

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F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved by DEN Project Manager in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.8 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces [**not exposed to public view**].

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.9 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces [**to receive trowel finish**] [**and**] [**to be covered with fluid-applied or sheet waterproofing, built-up or membrane**.

C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete

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by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces [**exposed to view**] .

2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed [**1/8 inch** (**3.2 mm**)].

3.10 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.11 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

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E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.12 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least [**one**month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.13 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by DEN Project

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Manager. Remove and replace concrete that cannot be repaired and patched to DEN Project Manager's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete. Limit cut depth to 3/4 inch (19 mm). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by DEN Project Manager.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in

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contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to DEN Project Manager's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to DEN Project Manager's approval.

3.14 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.

B. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.

   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.

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3. Air Content: ASTM C 231, pressure method, for normal-weight concrete;]one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
6. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure one set of five (5) standard cylinder specimens for each composite sample.
    b. Cast and field cure one set of five (5) standard cylinder specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C 39/C 39M.

    a. Test one (1) set of two (2) field-cured specimens at 7 days and one (1) set of two (2) specimens at 28 days. One (1) specimen shall be held in reserve for additional testing as needed.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
10. Test results shall be reported in writing to DEN Project Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by DEN Project Manager but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by DEN Project Manager. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by DEN Project Manager.
13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

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14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within [**48**] hours of finishing.

3.15 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

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 033000

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SECTION 050510 - WELDING

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. Welding is that work defined in American Welding Society (AWS) "Standard Welding Terms and Definitions - AWS A2.4" and as otherwise shown on Drawings.

1. All welding on this project shall comply with requirement of this Section, and other Contract Documents such as, but not limited to Drawings. If there is a conflict between Project Drawings, codes, and specifications, the more stringent shall apply.

B. Extent of welding Work is shown on Drawings, including schedules, notes and details to show size and location of welds. Welding Symbols shall be in accordance with AWS/A2.4-Standard Symbols for Welding, Brazing, and Nondestructive Examination.

C. Nothing stated in this Section shall be interpreted as diminishing or eliminating requirements stated in other Sections.

D. Related Sections:

1. This Section 050510 "Welding" will apply to all welding performed under all other sections of this specification.
2. Other Division 5, Division 22 and Division 23.

E. Related Requirements:

1. Drawings, General and Special conditions, general requirements and other applicable Technical Specifications apply to Work of this Section.

2. IEEE-1992. Only welding machines that have been tested and comply with harmonic distortion requirements of IEEE-1992 shall be allowed to operate off of DIA electrical power system.

1.3 REFERENCE STANDARDS

A. Welding shall 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.

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1. AISC - American Institute of Steel Construction.
2. AWS - American Welding Society.
3. API - American Petroleum Institute.
4. AWWA - American Water Works Association.
5. ASME - American Society of Mechanical Engineers.
6. ASTM - American Society for Testing and Materials.
7. ASNT - American Society for Nondestructive Testing.

1.4 SUBMITTALS

A. Product Data: Submit producers or manufacturer's specifications and installation instructions for all products, including, but not limited to those listed below. Include laboratory test reports and other data to show compliance with specifications (including specified standards).

1. Welding Electrodes: Submit manufactures specifications, to include recommended parameters and technique, for each electrode to be used on this project.
2. Include data substantiating that materials comply with requirements.

B. Submittal Requirements for Steel Studs:

1. Stud manufacturer's certification that the studs, as delivered, conform to the applicable requirements of AWS D1.1-2000, sections 7.2 and & 7.3.
2. Certified copies of the stud manufacturer's test reports covering the last completed set of in-plant quality control mechanical tests, required by AWS D1.1-2000, 7.3 for each diameter delivered. The quality control test shall have been made within the six-month period before delivery of the studs.
3. Certified material test reports (CMTR) from the steel supplier indicating diameter, chemical properties, and grade on each heat number delivered.
4. In the absence of Quality Control tests the provisions of AWS D1.1-2000, 7.3.4and 7.3.5 shall apply with the exception that DIA Project Manager or DIA Project Manager's representative will replace engineer in the process. All costs shall be at Contractor¹s expense.

C. Submit shop drawings as specified under Section 013325 "Shop and Working Drawings, Product Data and Samples" for all Work specified herein, including complete details and schedules for fabrication and assembly of members, procedures and diagrams. Shop drawings shall indicate how each and every component shall be welded. If another company manufactures a component to be welded to another part(s) or piece(s) to form a larger assembly, then the shop drawings shall include that manufacturer¹s recommended welding procedures for that component. Design Construction Drawings shall not be re-used as bases for submitted shop drawings. Shop drawings, which use reproductions of design plans or details, will not be reviewed. Drawings shall be submitted in complete units. Do not submit partial sets.

D. Shop drawings shall clearly indicate profiles, sizes and locations of structural members, connections, attachments, anchorage’s, framed openings, size and type of fasteners, and clearances. Indicate welded connections using standard AWS welding symbols, per AWS A2.4. Clearly indicate net weld lengths and sizes, root openings,

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bevel angles and other information required to satisfactorily complete welding operations.

E. Contractor shall submit fully dimensioned Isometric drawings (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. Spool drawings shall be submitted in in latest format as approved by Owner. Adobe Acrobat files shall not contain security. Other file formats will not be accepted.

F. Calculations required in other Sections shall show all pertinent members and pieces. Calculations shall be submitted prior to, or with, relevant shop drawing submittals. It is contractor's responsibility to insure that field construction uses connection design as submitted and reviewed.

G. Test Reports: Submit copies of all test reports conducted on shop and field welded connections. Include data on type(s) of tests conducted and test results. Reports must be sequentially numbered and submitted to the DIA Project Manager within 48 hours of completion.

H. Individual Welder Qualifications: Submit Welding Performance Qualification Records (WPQR) for all welders, shop and field, prior to any welding per Paragraph 1.5. B below.

I. Procedures: Submit Welding Procedure Specifications for all shop and field welding prior to any welding per Part 1 of this Section.

1.5 QUALITY REQUIREMENTS

A. Codes and Standards: Comply with provisions of following, as applicable:

1. AISC - American Institute of Steel Construction:

   a. AISC "Code of Standard Practice for Steel Buildings and Bridges", 1986.
   b. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including "Commentary" and Supplements thereto as issued.

2. American Welding Society (AWS) D1.1 "Structural Welding Code Steel" and all other applicable A.W.S codes (latest editions).
3. ASTM A 6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use".
4. All welding shall be performed in accordance with the latest addition of applicable AWS, API, ASME code and ASTM Standards.

B. Qualifications for Welding Work:

1. All Welders shall have been qualified through welding tests in accordance with applicable AWS code per paragraph 1.5.A above within one (1) year prior to welding taking place. Evidence of qualification shall be through Welding Performance Qualification Records (WPQR).

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2. All welder qualifications test shall be or shall have been administered and witnessed by an Independent Testing Agency (ITA), AWS Certified Welding Inspector, (CWI).
3. If recertification of welders is required, delay costs and retesting costs shall be borne by the Contractor.
4. Welding that is to take place at each and every type of joint shall be per approved AWS procedure for that type of joint. Evidence of intended procedure shall be through written Welding Procedure Specifications.
5. Any welding done without submission to and approval by the DIA Project Manager of Welding Performance Qualification Records of the individual welder(s) doing the welding and Procedure Specifications for the actual welding shall be considered defective and subject to the provisions of Title 17 of the General Conditions.
6. All WPS and WPQR qualification testing shall be in accordance with this specification and the applicable welding code requirements.

C. The Contractor shall periodically review each welders work quality and take any steps required to insure high quality work. This is in addition to Quality Control requirements.

D. Fabricator Qualifications: Minimum of three (3) years experience specializing in fabrication for similar projects.

E. Design of Members and Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the Work.

1. Promptly notify DIA Project Manager whenever design of members and connections for any portion of structure are not clearly indicated.

F. Welding and materials shall be inspected and tested by an Independent Testing Agency furnished and paid for by the Contractor. The Independent Testing Agency will have authority to reject weldments and materials. Such rejection may be based on visual inspection where, in the Inspector¹s opinion, the weldment or material would not pass more detailed investigation. Reference Article 3.01 below for inspection and testing requirements. DIA’s Quality Assurance Inspector(s), per the provisions of General Conditions Title 17, will also inspect welding and materials. Inspections by either the Independent Testing Agency or DIA’s Quality Assurance Inspector may take place in the mill, shop and field.

1. Promptly remove and replace materials or fabricated components that do not comply with requirements as set forth in the Contract Documents.

1.6 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

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PART 2 - PRODUCTS

2.1 MATERIALS

A. Electrodes for Welding: Comply with AWS Code. Use E70 grade minimum unless otherwise approved. Store all electrodes and welding materials inside and protect from moisture, corrosion, and any other damage. Damaged electrodes shall not be used.

2.2 FABRICATION

A. Shop Fabrication and Assembly: Fabricate and assemble components in shop to greatest extent possible.

1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

B. Holes for Other Work: Provide holes required for securing other work to components, and for passage of other work through components, as shown on final shop drawings.

1. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.
2. Cut, drill, or punch holes perpendicular to metal surfaces. The DIA Project Manager shall approve any enlarging of holes by flame cutting

C. Contractor will notify DIA Project Manager or DIA Project Manager's representative at least 48 hours prior to any commencing fabrication. Notification to include starting date and duration of the Work.

2.3 SHOP CLEANING AND PAINTING

A. Components to be painted are as shown on the Drawings.

1. Do not paint surfaces, which are to be welded.
2. Do not paint over welded joints until after Independent Testing Agency and DIA Quality Assurance Inspector have approved them.

PART 3 - EXECUTION

3.1 ERECTION

A. Do not enlarge misaligned or undersized holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged

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to admit bolts.

B. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members, which are not under stress, as acceptable to DIA Project Manager. Finish gas-cut sections equal to a sheared appearance when permitted.

C. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Once Independent Testing Agency and DIA Quality Assurance Inspector have approved welds, apply paint to exposed areas using same material as used for shop painting.

D. No welding machines are to be operated off of DIA power until such machines have been tested for harmonic distortion per IEEE-1992 and approved by DIA Project Manager.

E. Contractor will notify DIA Project Manager or DIA Project Manager's representative at least 48 hours prior to any inspections to be performed by ITA.

3.2 TESTING AND INSPECTION

A. Independent Testing Agency (ITA):

1. See Division 1 for Independent Testing Agency requirements.
2. The General Contractor shall provide the ITA for all subcontractors. Subcontractors shall not contract with a separate ITA.
3. Contractor will engage an Independent Testing Agency to inspect welded connections and to perform tests and prepare test reports. The Contractor's Quality Control Inspector will coordinate the inspections and tests performed by the testing lab inspectors and testing personnel.

    a. The Contractor’s Independent Testing Agency and DIA Project Manager’s staff shall conduct and interpret tests and state in each report whether test specimens comply with requirements, and specifically state any deviations therefrom. All reports shall be delivered to the DIA Project Manager. Results not complying with requirements are to be brought to the DIA Project Manager¹s attention within 24 hours of discovery. All reports shall be sequentially numbered.
    b. Provide access for Independent Testing Agency to places where work is being fabricated or produced so that required inspection and testing can be accomplished.
    c. The Independent Testing Agency shall inspect Work at the plant before shipment; however, DIA Project Manager reserves right, at any time before final acceptance, to reject material not complying with specified requirements.

        1) Inspections and tests conducted by the ITA or DIA 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 ITA does not relieve the Contractor of providing

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the required Quality Control Program.

d. Welding Inspection Personnel Qualifications: All visual welding inspections shall be performed by AWS Certified Welding Inspectors CWI, qualified in accordance with AWS QC1. Inspectors qualified in accordance with the most current edition of the American Society for Nondestructive Testing Recommended Practice No. SNT-TC 1A, shall perform all non-destructive inspections other than visual inspections
e. Independent Testing Agency Inspectors working for the Contractor shall identify with a distinguishing mark all parts and joints they have inspected and accepted. Marks to be visible from at least 50 feet. DIA Project Manager and the Quality Control Inspectors shall mutually agree upon identifying marks.
f. Independent Testing Agency welding inspector shall be on job site however much time it takes to guaranty that all requirements of Project Specifications and codes are being met and provide written reports showing specific requirements have been met. Shop inspections by ITA welding inspector shall be performed in such a manor as to guaranty that all provisions of Project Specifications and codes are being met and provide written reports showing specific requirements have been met.

4. The Contractor shall furnish such facilities and provide such assistance as may be required for carrying out the inspection prescribed herein. The Contractor shall notify the Independent Testing Agency and the DIA Project Manager at least two weeks in advance of the start of any qualification testing for welding.
5. The Testing Agency's Inspector will perform the the Inspector's duties in such a way that neither fabrication nor erection is unnecessarily delayed or impeded. The Testing Agency shall notify the DIA Project Manager of any scheduled inspections at least 48 hours prior to such time. The DIA Project Manager shall also be notified as soon as possible prior to any unscheduled inspections. In no case will the inspector recommend or prescribe the method of repair of a defect.
6. Inspection of welding will be such as to assure that all requirements of Project Specifications AWS D1.1, and other applicable welding codes are being complied with. Reports shall show the following items as being in conformance, but not be limited to just the items shown:

   a. Verify that electrodes used for welding conform to the requirements Manufacturer, AWS, and other applicable Welding Codes and Standards.
   b. Verify that the approved Welding Procedure Specifications and the approved welding sequence are followed without deviation.
   c. Verify that only welding operators and welders who have been properly qualified will perform the welding. The inspection agency will witness such qualification testing of welding operations and welders, as may be required.
   d. Verify that the fit up, joint preparation, size, contour, extent of reinforcement, and length and location of welds conform to specified requirements such as but not limited to applicable welding codes, Welding Procedure Specifications, and Drawings.
   e. Review Mill Test Reports of material for compliance with Project Specifications, all applicable Codes, and Drawings.
   f. ITA inspection reports shall list all inspected, nonconforming, repaired, and accepted welds.

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7. DIA Project Manager shall be informed at least 48 hours prior to shop and field welding so random inspections can be performed as stipulated in these specifications and General Conditions, TITLE 17.
8. All welders shall mark their welds with identifying marks. Contractor shall furnish DIA Project Manager with list of welders and their marks. List shall be updated each time a welder is added or subtracted.

B. Structural Steel:

1. The Independent Testing Agency will test shop and field welds per ASTM E 543 and applicable welding code requirements as follows:

   a. All welds: 100% visual.
   b. Delamination and non-metallic inclusion tests of base metal:

      1) Plates and portions of rolled shapes three inches or greater in thickness shall be 100% ultrasonically tested in a zone extending six inches in all directions from any full penetration groove weld which transmits stress through the thickness of the material, or any weld which, because of restraint and/or weld shrinkage will, in the opinion of the inspector, cause significant through-thickness (Z-direction) stress in the material. Such tests shall be made after completion of welding. Acceptance Criteria for such tests shall be in accordance with ASTM A435.

   c. All full penetration or partial penetration groove welds require 100% ultrasonic testing.
   d. All fabricated trusses including all fabricated trusses acting, as girders shall be 100% magnetic particle tested.
   e. Studs on all embed assemblies: 100% of studs tested by hammer method and visual inspection.
   f. Wall and roof deck connections:

      1) 10% Magnetic Particle.

   g. All other welded connections: 10% Magnetic Particle.
   h. Additional Testing shall be performed by the Independent Testing Agency.

2. Additional Field Weld Testing:

   a. In addition, if defective welds are discovered, the remaining un-inspected welds shall receive such ultrasonic or magnetic particle inspection as may be required by the DIA Project Manager. If more than 10 percent of a welder's welds fail or when a CWI (Certified Welding Inspector) feels that the quality of the qualified welder’s work appears to be below the requirements of the applicable AWS Code, he/she shall be removed from the job and retested to demonstrate compliance with AWS D1.1 (Latest Edition) or other applicable AWS codes and all other applicable AWS codes.
   b. Additional testing shall be required if more than 10% of the Magnetic Particle tested welds are rejected. Then an additional 10% will be tested

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using either Magnetic Particle or Dye Penetrant Testing. This 10% additional testing shall be repeated until rejection rate drops below one in 10.

c. When ultrasonic indications arising from the weld root can be interpreted as either a weld defect or the backing strip, the backing strip shall be removed at the expense of the contractor, and if no root defect is indicated on this retest, and no significant amount of the base and weld metal have been removed, the joint needs no further repair or welding. If a defect is still indicated, it shall be repaired.

d. The welding inspector will have the authority to reject weldments. Such rejection may be based on visual inspection where in the welding inspector's opinion the weldment would not pass a more detailed investigation.

e. Reports by the Independent Testing Agency inspector will contain, as a minimum, an adequate description of each weld tested, the identifying mark of the welder responsible for the weld, a critique of any defects noted by visual inspection or testing, and a statement regarding the acceptability of the weld tested, as judged by current A.W.S. standards. A copy of all tests results, including ultrasonic and x-ray, shall be provided to the DIA Project Manager within 48 hours of the test occurrence. This requirement includes all failed tests. Any test that shows work not in conformance with the contract requirement shall be retaken after the non-conformity is Corrected. The retest shall refer to the failed test. Radiographic testing may be substituted for ultrasonic.

3. Stud Connectors

   a. Stud connectors: The testing agency will inspect headed stud connectors as follows:

      1) All studs shall be acoustically inspected. Studs, which do not ring when struck with a hammer, shall be bent 15 degrees. If no fracture occurs, stud is considered acceptable and left bent.
      2) In addition to the above, not less than one of each 50 studs shall be tested by bending 15 degrees. If no fracture occurs, stud is considered acceptable and left bent.
      3) If at any time the number of rejectable studs on any level of structural steel framing exceeds 3% additional testing in accordance with paragraph above shall be performed on one of each 25 studs at this level and this increased frequency of testing shall be continued on all succeeding levels until the number of rejectable studs at a level is 3% or less. All cost of additional testing required by this paragraph shall be borne by the Contractor.
      4) 100% visual inspection to be performed in accordance with AWS D1.1 acceptance criteria.

4. Correct deficiencies in structural steel work, which inspections and laboratory test reports have indicated to be not in compliance with requirements. Perform additional tests, at Contractor¹s expense, as may be necessary to reconfirm any non-compliance of original work, and as may be necessary to show compliance of corrected work.

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C. Metal Decking:

1. Welding shall be performed in accordance with AWS D1.3 and this specification.
2. 100 % visual inspection of all welds, per AWS D1.3 Structural Welding Code Sheet Steel.

    a. Requires the removal of all slag from welds.

3. 10% Magnetic Particle testing of all welds.

    a. Additional testing shall be required if more than 10% of the Magnetic Particle tested welds are rejected. Then an additional 10% will be tested using either Magnetic Particle or Dye Penetrant Testing. This 10% additional testing shall be repeated until rejection rate drops below one in 10.

4. All weld areas shall be repaired after inspection. Repair painted decking per Section 053100 "Steel Decking".

D. Metal Fabrications:

1. Welding shall be performed in accordance with applicable AWS welding code and these specifications.
2. 100% visual inspection of all welds.
3. 10% Magnetic Particle testing of all welds.

    a. Additional testing shall be required if more than 10% of the Magnetic Particle tested welds are rejected. Then an additional 10% will be tested using either Magnetic Particle or Dye Penetrant Testing. This 10% additional testing shall be repeated until rejection rate drops below one in 10.

4. Applicable paragraphs of Structural Steel paragraph above shall be met also.

E. Concrete Reinforcing Bars:

1. Welding shall be performed in accordance with this specification, AWS D1.4, and other applicable AWS Codes and Standards.
2. 100 % visual inspection of all welds, Per AWS D1.4 Structural Welding Code Reinforcing Steel, or other AWS Codes as applicable.
3. 10% Magnetic Particle testing of all welds.

    a. Additional testing shall be required if more than 10% of the Magnetic Particle tested welds are rejected. Then an additional 10% will be tested using either Magnetic Particle or Dye Penetrant Testing. This 10% additional testing shall be repeated until rejection rate drops below one in 10.

F. Precast Concrete:

1. All Shop and Field welding including embed assemblies, shall be inspected per

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these specifications, AISC, AWS D1.1, AWS D1.4, and other applicable AWS codes.

2. In addition to the requirements listed below, the requirements of paragraphs for Structural Steel and Concrete Reinforcing Bars above shall apply to this section also.
3. AISC Manual of Steel Construction, Chapter J, Section J2 shall be complied with.

    a. If welds with larger effective throat thickness than shown in Table J2.2 are to be used, random testing will have to be performed on shop and field welds to insure that effective throats sizes are being met.

        1) Three percent of all such welds shop and field will have to be tested by removing, cross sectioning, and Macroetch tested as called out in AWS D1.4-98, Section 6.2.5.2.
        2) Welds to be tested will be randomly picked by DIA Project Manager.

4. Weld plates shall NOT be bent by hammering or heating to close up gaps in connections between uneven embeds.

    a. Filler plates shall be used in accordance with AWS D1.1.
    b. Designer of Record shall review all connections requiring filler plates 1/4 and thicker for compliance with design load requirements.
    c. Minimal hammering and bending will be allowed on plate and connection designated as “For Erection Only”. Drawings shall clearly designate which welds are for erection only. Drawings shall clearly state that welds indicated as “for erection only”, have no value after structure is completed.

        1) An assortment of prebent plates shall be furnished by Precast supplier to minimize the amount of beating on connection plates. Plates shall be bent in 1/2-inch increments and no plates shall be bent any more than 1/2 inch after one side is welded in place.
        2) All welds, erection or permanent, shall be applied and inspected per applicable AWS code. The only exception will be to allow the connection plates for the “for erection only” welds to be bent a maximum of 1/2 inch.

5. No welding is allowed unless specifically shown on Drawings.

    a. All welds shown on Drawings are structural and shall meet all requirements of Project Specifications and welding codes.

G. Sheet Steel:

1. Welding shall be in accordance with AWS D1.3 Structural Welding Code- Sheet Steel.
2. Inspection:

    a. 100 % visual in accordance with acceptance criteria of AWS D1.3.
    b. 10% Magnetic Particle testing of all welds.
    c. Additional testing shall be required if more than 10% of the Magnetic Particle tested welds are rejected. Then an additional 10% will be tested

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using either Magnetic Particle or Dye Penetrant Testing. This 10% additional testing shall be repeated until rejection rate drops below one in 10.

H. Division 22 and Division 23 - Basic Mechanical Materials and Methods:

1. All welding in Division 22 and Division 23 shall comply with the applicable AWS, ASME, AWWA, and API codes, latest editions.
2. All shop and field welds will be inspected per these specifications and applicable code for work being performed.
3. All welds shall be 100% visually inspected by ITA supplied by Contractor. Additional testing shall be as required by other parts of this Section, applicable codes, DIA Project Manager and Designer of Record.

    a. Natural Gas piping (underground and transportation mains upstream of the meter): ASME B31.8

        1) 100% visual inspection per acceptance criteria of ASME B31.8.
        2) All other requirements of ASME B31.8 as required for the application.

    b. Natural Gas piping (less than 5 psi and downstream of the meter): ASME B31.9:

        1) 100% visual inspection per acceptance criteria of ASME B31.9.
        2) All other requirements of ASME B31.9 as required for the application.

    c. Hot and chilled water piping/Hydronic Piping: ASME B31.9:

        1) 100% visual inspection per acceptance criteria of ASME B31.9.
        2) All other requirements of ASME B31.9 as required for the application.

    d. Hot water piping (in excess of 200ºF) /Hydronic Piping: ASME B31.3:

        1) 100% visual inspection per acceptance criteria of ASME B31.3.
        2) All other requirements of ASME B31.1 as required for the application.

    e. Ductwork applicable AWS Code, such as but not limited to AWS D1.3 Structural Welding Code-Sheet Steel or AWS D9.1M/D9.1-Sheet Metal Welding Code:

        1) 100% Visual inspection per acceptance criteria of applicable code.
        2) Magnetic Particle Test requirements are the same as paragraph above for Structural Steel.
        3) Additional requirements of SMACNA duct construction standards.

    f. Fuel Piping: ASME B31.4:

        1) 100% visual inspection per acceptance criteria of ASME B31.4.
        2) All other requirements of ASME B31.4 as required for the application.

    g. Refrigerant Piping: ASME B31.5:

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1) 100% visual inspection per acceptance criteria of ASME B31.5.
2) All other requirements of ASME B31.5 as required for the application.

h. Steam piping: ASME B31.1:

1) 100% visual inspection per acceptance criteria of ASME B31.1.
2) All other requirements of ASME B31.1 as required for the application.

i. Piping, ductwork and mechanical equipment supports: AWS D1.1: and other applicable AWS Codes.

1) 100 % visual inspection.
2) Magnetic Particle Test requirements are the same as 4.02 Structural Steel.

j. Water Lines: Per AWWA, AWS D1.1 latest edition, and Denver Water Board Specifications. If there is a conflict the more stringent shall apply:

1) 100% visual inspection per AWS D1.1 visual acceptance criteria.
2) AWWA requires that welds be 100% Dye Penetrant Tested in place of Magnetic Particle testing.

4. Forged fittings, for branch connections and etc. shall be welded in accordance with this specification, ASME B31.1, and manufacturer's recommendations. In the event of a conflict, the more stringent shall apply:

a. Fittings shall be full penetration welded.
b. Inside of fitting shall be inspected for full penetration. This shall be done prior to any welding on inside if so required. If weld is required on inside of full penetration joint, it shall be ground or back gouged to sound base metal.

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 applicable unit price item, work order or lump sum bid item.

END OF SECTION 050510

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SECTION 051200 - STRUCTURAL STEEL FRAMING

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. Structural steel.
2. Grout.

B. Related Sections:
1. Section 053100 "Steel Decking" for field installation of shear connectors through deck.
2. Section 055000 "Metal Fabrications" for [miscellaneous steel fabrications and other metal items not defined as structural steel.
3. Section 055100 "Metal Stairs."
4. Section 099123 "Interior Painting" for surface-preparation and priming requirements.

C. Extent of structural steel Work is shown on drawings, including schedules, notes and details to show size and location of members, typical connections, and type of steel required.

D. Structural steel is that work defined in American Institute of Steel Construction (AISC) "Code of Standard Practice" and as otherwise shown on drawings.

E. Members in a structure that carry an imposed load in addition to their own weight.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

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1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
2. Welded built-up members with plates thicker than 2 inches (50 mm).
3. Column base plates thicker than 2 inches (50 mm).

D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.4 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.

1.5 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator**,** including comprehensive engineering analysis by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC 360 .
2. Use [ASD; data are given at service-load level].

B. .

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Submit producer's or manufacturer's specifications and installation instructions for the following products. Include laboratory test reports and other data to show compliance with specifications, including specified standards.

1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
2. High strength bolts (each type), including nuts and washers.
3. Structural steel primer paint.
4. Shrinkage resistant grout.
5. Welding Electrodes: Per Section 059990 "Welding".
6. Provide fully traceable certificates of compliance with ASTM.
7. Include data substantiating that materials comply with requirements.

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B. Shop Drawings: Show fabrication of structural-steel components. Submit shop drawings for all Work specified herein, including complete details and schedules for fabrication and assembly of structural steel members, procedures and diagrams.

1. Submit design calculations and drawings prepared under the supervision and sealed by a professional engineer registered in Colorado for all standard shear connections moment connections, and fabricated truss member connections as shown on drawings.
2. Submit non-standard connections for design review.
3. Design construction drawings shall not be re-used as bases for submitted shop drawings. Shop drawings that use reproductions of design plans or details may not be reviewed.
4. Erection and piece drawings shall be submitted in complete units. Do not submit partial sets. Calculations shall be submitted only with relevant erection plans with clear references between each.
5. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
6. Include embedment drawings.
7. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
8. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
9. Identify members and connections of the seismic-load-resisting system.
10. Indicate locations and dimensions of protected zones.
11. Identify demand critical welds.
12. Shop drawings shall clearly indicate profiles, sizes, and locations of structural members, connections, attachments, anchorage's, framed openings, size and type of fasteners, and clearances. Clearly indicate net weld lengths and sizes, root openings, bevel angles and other information required to satisfactorily complete welding operations.
13. Calculations shall show all pertinent members and pieces. Calculations shall be submitted prior to, or with, relevant shop drawing submittals. It is contractor's responsibility to insure that field construction uses connection design as submitted and reviewed.
14. For structural-steel connections indicated to comply with design loads, include structural analysis data [signed and sealed by the qualified professional engineer responsible for their preparation].

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint [whether prequalified or qualified by testing], including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand critical welds.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer, fabricator, and professional engineer.

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B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength bolt-nut-washer assemblies.
4. Shear stud connectors.
5. Shop primers.
6. Nonshrink grout.

F. Source quality-control reports.

G. Surveys: Submit certified copies of each survey conducted by a registered professional engineer, showing elevations and locations of all base plates and anchor bolts to receive structural steel, and final elevations and locations for major members. Indicate discrepancies between actual installation and Contract Documents.

H. Submit WPS (Welding Procedure Specifications) and WPQR (Welder performance Qualification Records) in accordance with Specification 059990 "Welding".

I. Submit Quality Control Plan for approval by DIA Project Manager and Designer of Record.

1.8 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".

1.9 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category [**ACSE**]

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel." Reference Section 050510 "Welding" for general welding requirements.

1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required

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by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

D. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. Preinstallation Conference: Conduct conference at location and time as determined by DIA Project Manager.

F. Qualifications for welding work shall be in accordance with Specification Section 059990 "Welding" and applicable welding and inspection codes.

G. The Contractor shall periodically review each welder's work quality and take any steps required to endure high quality work. This is in addition to Quality Control requirements.

H. Fabricator Qualifications: Minimum of three (3) years experience specializing in fabrication of structural steel for similar projects and be an AISC Class III shop.

I. Fabricator shall provide full traceability of all steel used in the fabrication of this project. Procedures for providing traceability shall be included in the Quality Control Plan.

J. Source Quality Control: Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified independent inspection agency furnished and paid for by contractor.

K. Promptly remove and replace materials or fabricated components which do not comply.

L. Design of Members and Connections: Details shown are typical; similar details apply to similar conditions, unless otherwise indicated. Verify dimensions at site whenever possible without causing delay in the Work.

M. Promptly notify DIA Project Manager whenever design of members and connections for any portion of structure are not clearly indicated.

N. Paint testing: Provide certification that factory applied paint complies with specified requirements. Submit copy to DIA Project Manager prior to steel erection.

O. Independent Testing Agency or DIA Project Manager's Quality Control Inspector will have authority to reject weldments. Such rejection may be based on visual inspection where, in the opinion of the Independent Testing Agency or DIA Project Manager, weldment would not pass more detailed investigation.

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1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site at such intervals to insure uninterrupted progress of work. All material shall bear easily readable identification mark numbers as noted on shop drawings. Deliveries to the jobsite shall be made in the order that material is being erected. The direction of camber shall be clearly shown.

B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast in place concrete or masonry, in ample time to not to delay work.

C. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

D. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.11 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Metal Surfaces, General: For fabrication of steel exposed to view, use only materials which are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names and roughness.

B. Channels, Angles[, [ASTM A 36/A 36M]

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C. Plate and Bar: [ASTM A 36/A 36M]

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade [B]

E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

1. Finish: Black, except where indicated to be galvanized.

2. Weight Class: [Standard].
3. Finish: [Black except where indicated to be galvanized.

F. Steel Forgings: ASTM A 668/A 668M.

G. Welding Electrodes: Comply with AWS requirements and with Specifications Section 059990 "Welding", and applicable welding codes and specifications.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, (ASTM A 563M, Class 8S) heavy-hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M), Type 1, hardened carbon-steel washers; all with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 325 (ASTM F 959M, Type 8.8), compressible-washer type with plain finish.

B. Threaded Rods: [ASTM A 36/A 36M]

1. Nuts: ASTM A 563 (ASTM A 563M) []hex carbon steel.
2. Washers: [ASTM F 436 (ASTM F 436M), Type 1, hardened] [ASTM A 36/A 36M] carbon steel.
3. Finish: [Plain] [

C. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

D. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

2.3 PRIMER

A. Primer: Comply with Section 099123 "Interior Painting."

B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

C. Galvanizing Repair Paint: ASTM A 780.

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2.4 GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
6. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, [mechanically thermal cut,]or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.

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H. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches (250 mm) o.c. unless otherwise indicated.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning. Any enlarging of holes by flame cutting shall be performed only if approved by the DIA Project Manager.
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
4. Provide threaded nuts welded to framing, and other specialty items as indicated to receive other work.

J. Expansion Joints: Provide expansion joints in steel shelf angles to match locations of expansion joints in structural steel frame.

2.6 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
5. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
6. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
7. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
8. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
9. SSPC-SP 8, "Pickling."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

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1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

2.7 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
2. Galvanize [lintels] [shelf angles] [and] [welded door frames] attached to structural-steel frame and located in exterior walls.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be[tested and] inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

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1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Surveys: Employ a registered professional engineer or land surveyor for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to DIA Project Manager along with a suggested plan on how to correct the discrepancy.

1. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon with DIA Project Manager.

B. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and all final connections are made. Provide temporary guide lines to achieve proper alignment of structures as erection proceeds. Temporary shoring and bracing shall be designed by a Licensed Colorado Professional Engineer.

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1. The Engineer shall inspect finished shoring and bracing and document compliance with the design plans.

C. Temporary Planking: Provide temporary planking handrails, nets, anchorages and working platforms as necessary to effectively and safely complete work.

D. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

E. Base [Bearing] [and] [Leveling] Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. [Snug-tighten] anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure.[Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.]

F. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

G. Set structural frames accurately to lines and elevations indicated. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure within specified AISC tolerances and as follows:

   a. At all slab edge conditions, provide a maximum deviation from grid line (or dimensioned point from grid line), to beam or column center, on the exterior or open side, of 1/2" at any given point. Grid line shall be considered a theoretically perfect plane.

   b. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

H. Splice members only where indicated and approved on shop drawings.

I. Do not use thermal cutting during erection unless approved by DIA Project Manager. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

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J. Do not enlarge unfair holes in members by burning or using drift pins, except in secondary members. Ream holes that must be enlarged to admit bolts.

K. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

L. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.

M. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds. Where welding to existing steel, clean existing steel surfaces prior to welding.

N. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members that are not under stress, as acceptable to DIA Project Manager. Finish gas cut sections equal to a sheared appearance when permitted.

O. Touch Up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

P. Beam Members: Deviation of member working point horizontal location and elevation with respect to the supporting member shall not exceed +_/- 1/16” from the location and elevation shown on the drawings.

1. Leveling and Plumbing: Based on mean temperature of 70 degrees F.
2. Compensate for difference in temperature at time of erection.

Q. Headed Stud Shear Connectors: Automatically end weld in accordance with Specification Section 059990 "Welding", AWS D1.1 and manufacturer’s printed instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: [Snug tightened]

B. Weld Connections: Comply with AWS D1.1/D1.1M[and AWS D1.8/D1.8M] for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work. Reference Section 050510 "Welding" for general welding requirements.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

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2. Remove backing bars or runoff tabs[**where indicated**], back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect [field welds] [and] [high-strength bolted connections].

B. Bolted Connections: Bolted connections will be[tested and] inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

    a. Liquid Penetrant Inspection: ASTM E 165.
    b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    c. Ultrasonic Inspection: ASTM E 164.
    d. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

1. Additional testing, if required, will be performed at Contractor's expense, as may be necessary to reconfirm any non-compliance of original work, and as may be necessary to show compliance of corrected work.

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3.7 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 099123 "Interior Painting."

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 051200

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SECTION 053100 - STEEL DECKING

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. Composite floor deck.

B. Related Requirements:

   1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
   2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
   3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
   4. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, product, paint and primer indicated.

   1. Provide test data for mechanical fasteners used in lieu of welding for fastening deck to supporting structures.
   2. Include data substantiating that materials comply with requirements.

B. Shop Drawings:

   1. Include layout and types of deck panels, anchorage details, closure strips, supplementary framing, reinforcing channels, pans, cant strips cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

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C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Powder-actuated mechanical fasteners. Powder-actuated fasteners to be used only if approved by DEN Project Manager.
2. Acoustical roof deck.

D. Evaluation Reports: For steel deck.

E. Field quality-control reports.

F. Submit bill of materials for all items needed to install the material listed in this section for the Project.

1.5 QUALITY ASSURANCE

A. Comply with the following:

1. American Iron and Steel Institute (AISI), "Specification for the Design of Cold Formed Steel Structural Members."
2. Steel Deck Institute (SDI), "Design Manual for Composite Decks, Form Decks, and Roof Decks."

B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel." Reference Section 050510 "Welding" for general welding requirements.

D. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

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PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2. .

2.2 COMPOSITE FLOOR DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
4. Consolidated Systems, Inc.; Metal Dek Group.
5. Cordeck.
6. DACS, Inc.
7. Epic Metals Corporation.
8. Marlyn Steel Decks, Inc.
9. New Millennium Building Systems, LLC.
10. Nucor Corp.; Vulcraft Group.
11. Roof Deck, Inc.
12. Verco Manufacturing Co.
13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
14. or approved equal.

B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), [**G60 (Z180)** zinc coating.
2. Profile Depth: **As indicated**.
3. Design Uncoated-Steel Thickness: [**0.0474 inch (1.20 mm)**]
4. Span Condition: **As indicated**.

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2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile [**indicated**] [**recommended by SDI Publication No. 31 for overhang and slab depth**].

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, [**0.0598 inch (1.52 mm)**] thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.

J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.

K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck, with 3-inch- (76-mm-) wide flanges and [**level**] [**sloped**] recessed pans of 1-1/2-inch (38-mm) minimum depth. For drains, cut holes in the field.

L. Galvanizing Repair Paint: [**ASTM A 780**].

M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

N. Acoustic Sound Barrier Closures: Manufacturer's standard mineral fiber closures.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

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B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FABRICATION

A. General: Form deck units in lengths to span three or more supports, with flush, telescoped, or nested 2-inch laps at ends and interlocking or nested side laps, of metal thickness, depth, and properties as indicated on the drawings.

B. Roof Deck Units: Provide deck configurations that comply with SDI "Specifications and Commentary for Steel Roof Deck."

C. Acoustical Roof Deck Units:

1. Single pan units: Single pan fluted units with vertical webs perforated with approximate 5/32 inch diameter holes staggered 3/8 inch o.c. Provide mineral fiber acoustical insulation strips of profile to fit void space between vertical ribs.
2. Multiple pan cellular units: Composite units consisting of upper fluted section combined with lower flat plate section having interlocking side laps and approximate 5/32 inch perforations staggered on 3/8 inch centers under cells formed by upper unit. Provide mineral fiber acoustical insulation strips of profile to fit void space of each cell.

D. Composite Steel Floor Deck: Fabricate deck units with integral embossing or raised pattern to furnish mechanical bond with concrete slabs. Fabricate open beam deck units with fluted section having interlocking side laps.

E. Metal Cover Plates: Fabricate metal cover plates for end abutting floor deck units of not less than same thickness as decking. Form to match contour of deck units and approximately 6 inches wide.

F. Metal Closure Strips: Fabricate metal closure strips, for cell raceways and openings between decking and other construction, of not less than 0.045 inch min. (18 gage) sheet steel. Form to provide tight fitting closures at open ends of cells or flutes and sides of decking.

3.3 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

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1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Do not place deck units on concrete supporting structure until concrete has cured and is dry.

I. Coordinate and cooperate with structural steel erector in locating decking bundles to prevent overloading of structural members.

J. Do not use floor deck units for storage or working platforms until permanently secured.

K. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

L. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

M. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work.

N. Use welding washers where recommended by deck manufacturer.

O. Mechanical fasteners, either powder actuated or pneumatically driven, may be used in lieu of welding if approved by DEN Project Manager.

1. Locate mechanical fasteners and install in accordance with deck manufacturer's instructions. Where decking will be used to contain fluid materials, such as fresh concrete, deck shall be placed so that fluid will not leak through or underneath.

P. Mechanically fasten side laps of adjacent deck units between supports, at intervals not exceeding 36 inches o.c., using self tapping No. 8 or larger machine screws.

Q. Keep the interiors of cells that will be used as raceways free of welds having sharp points or edges.

R. Cutting and Fitting: Cut and neatly fit deck units and accessories around other work projecting through or adjacent to the decking, as shown.

S. Reinforcement at Openings: Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking, and support of other work shown.

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T. Hanger Slots or Clips: Provide UL approved punched hanger slots between cells or flutes of lower element where floor deck units are to receive hangers for support of ceiling construction, air ducts, diffusers, or lighting fixtures.

1. Hanger clips designed to clip over male side lap joints of floor deck units may be used instead of hanger slots.
2. Locate slots or clips at not more than 14 inches o.c. in both directions, not over 9 inches from walls at ends, and not more than 12 inches from walls at sides, unless otherwise indicated.
3. Provide manufacturer's standard hanger attachment devices. Submit manufacturer's material data and instructions to DEN Project Manager for acceptance.

U. Joint Covers: Provide galvanized metal joint covers at abutting ends and changes in direction of floor deck units, except where taped joints are required.

V. Preparation: Clean top flange of beams to receive studs of all debris. Field weld studs to structural members after all steel framing, deck, and forms are in place. Install deck so that bottom plate or rib is in continuous contact with the surface to receive studs.

W. Shear Stud Connector Capacity: Number of shear connectors indicated on Drawings is based on 100% of allowable capacity for shear connectors in normal weight or lightweight concrete as listed in the AISC Specification. Determine actual shear connector capacities by tests on each type of deck supplied and number of shear connectors required in each rib. If additional shear connectors are required due to decreases in capacity of shear connectors for type of deck and stud placement supplied, provide additional shear connectors at no additional cost to Owner.

X. Installation: Install shear connectors in accordance with manufacturer's published instructions. Use only personnel and equipment authorized by deck manufacturer. Use through-deck shear connector welding where deck material thickness permits proper weld fusion to develop required connector capacity.

Y. Shear stud testing is specified in Section 051200 "Structural Steel Framing".

Z. Closure Strips: Provide metal closure strips at open uncovered ends and edges of roof decking and in voids between decking and other construction. Weld into position to provide a complete decking installation.

AA. Provide flexible closure strips instead of metal closures, at Contractor's option, wherever their use will ensure complete closure. Install with adhesive in accordance with manufacturer's instructions.

BB. Touch Up Painting: After decking installation, wire brush, clean, and paint scarred areas, welds, and rust spots on top and bottom surfaces of decking units and supporting steel members.

CC. Touch up galvanized surfaces with galvanizing repair paint applied in accordance with manufacturer's instructions.

DD. Touch up painted surfaces with same type of shop paint used on adjacent surfaces.

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EE.

3.4 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: [**5/8 inch (16 mm)**], nominal, or elongated welds of equal strength..
2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches (305 mm) apart, or as indicated. .
3. Weld Washers: Install weld washers at each weld location.
4. Reference Section 050510 "Welding" for general welding requirements.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches (914 mm), and as follows:

1. Mechanically fasten with self-drilling, No. 8 (4.0-mm-) diameter or larger, carbon-steel screws.
2. Mechanically clinch or button punch.
3. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of [**1-1/2 inches (38 mm)**] with end joints as follows:

1. End Joints: **Lapped or butted at Contractor's option**.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Testing agency shall conduct and interpret inspections and tests and state in written reports all findings and conclusions with reference made to specific deck location, date, ambient conditions, and specific reasons for acceptance, or deviations.

2. Steel deck shall be inspected and accepted per the "AWS-Sheet Welding Specifications".

B. Field welds will be subject to inspection. Any steel deck welded connection which is not acceptable per these specifications shall be repaired with screw connections at the ratio of two (2) #8 minimum screws for each deficient weld.

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C. Testing agency will report inspection results promptly and in writing to Contractor and DEN Project Manager.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.6 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on [**both surfaces**of prime-painted deck immediately after installation, and apply repair paint.

1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

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 053100

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SECTION 054000 - COLD-FORMED METAL FRAMING

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. Exterior non-load-bearing wall framing.
2. Ceiling joist framing.
3. Soffit framing.

B. Related Requirements:

1. Section 050510 "Welding" for general welding requirements.
2. Section 055000 "Metal Fabrications" for masonry shelf angles and connections.
3. Section 092216 "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.
4. Section 092216 "Non-Structural Metal Framing" for steel framing for gypsum board and plaster partitions and ceilings.
5. Section 092900 "Gypsum Board" for interior gypsum board, exterior gypsum board for ceilings and soffits, and tile backing boards.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at location and time as determined by DEN Project Manager .

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cold-formed steel framing product and accessory.

1. Include data substantiating that materials comply with requirements.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.

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2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

C. Samples: Submit one foot long sample of each type of stud, head and runner channels, expansion head track, fasteners, anchors, and accessories.

D. Certificate from manufacturer stating that all materials are per Contract requirements and providing proof of minimum five (5) years experience manufacturing products required of similar size.

E. Certificate from installer evidencing a minimum five (5) years successful experience installing this type of work on projects.

F. Delegated-Design Submittal: For cold-formed steel framing.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.

1. Steel sheet.
2. Expansion anchors.
3. Mechanical fasteners.
4. Vertical deflection clips.
5. Horizontal drift deflection clips
6. Miscellaneous structural clips and accessories.

D. Research Reports: For non-standard cold-formed steel framing, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
3. Reference Section 050510 "Welding" for general welding requirements.

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D. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

E. Component Design: Calculate structural properties of studs and joists in accordance with American Iron and Steel Institute (AISI) "Specification for Design of Cold Formed Steel Structural Members".

F. Fire Rated Assemblies: Where framing units are components of assemblies indicated for a fire resistance rating, including those required for compliance with governing regulations, provide units which have been approved by governing authorities having jurisdiction.

G. Pre-installation conference: Prior to installation of Work, meet at the project site or other mutually agreed location with installer, contractor, DEN Project Manager, DEN Structural Engineer and other job related contractors including representatives of curtain wall installer and preformed siding installer.

H. Warranty: Installer to warrant system for two (2) years, including framing and finish.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

B. Deliver to project site in manufacturer's unopened containers or bundles, fully identified with name, brand, type, and grade. Store off ground in a dry ventilated space or protect with breathable waterproof tarpaulins.

1.8 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alabama Metal Industries Corp.
2. AllSteel & Gypsum Products, Inc.
3. American Studco, Inc.
4. Bostwick Steel Framing Co.
5. California Expanded Metal Products Company (CEMCO).
6. Clark Western Building Systems, Inc.

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7. Consolidated Fabricators Corp.; Building Products Division.
8. Consolidated Systems, Inc.
9. Craco Manufacturing, Inc.
10. Custom Stud, Inc.
11. Dale Industries Inc.
12. Design Shapes in Steel.
13. Dietrich Metal Framing; a Worthington Industries Company.
14. Formetal Co. Inc. (The).
15. Marino/WARE.
16. Milcor Division, Inryco Inc.
17. MBA Building Supplies, Inc.
18. Olmar Supply, Inc.
19. Quail Run Building Materials, Inc.
20. SCAFCO Corporation.
21. Southeastern Stud & Components, Inc.
22. State Building Products, Inc.
23. Steel Construction Systems.
24. Steel Structural Systems.
25. Steeler, Inc.
26. Super Stud Building Products, Inc.
27. Telling Industries, LLC.
28. The Steel Network, Inc.
29. United Metal Products, Inc.
30. U.S. Gypsum Co.
31. United Steel Manufacturing
32. Western Metal
33. or approved equal.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated.
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
   a. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/240 of the wall height.
   b. Ceiling Joist Framing: Vertical deflection of 1/240 of the span.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).

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4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:

   a. Upward and downward movement of 1 inch (25 mm).

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Design Standards:

1. Floor and Roof Systems: AISI S210.
2. Wall Studs: AISI S211.
3. Headers: AISI S212.
4. Lateral Design: AISI S213.

D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

A. System Components: With each type of metal framing required, provide manufacturer's standard steel runners (tracks), blocking, lintels, clip angles, shoes, reinforcements, fasteners, and accessories as recommended by manufacturer for applications indicated, as needed to provide a complete metal framing system.

B. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

C. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: ST33H (ST230H) ST50H (ST340H)
2. Coating: G60 (Z180), A60 (ZF180).

D. Steel Sheet for Vertical Deflection Drift Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 33 (230) 50 (340), Class 1 or 2.
2. Coating: G60 (Z180).

E. Finish of installation accessories to match that of main framing components, unless otherwise indicated.

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F. Fasteners: Provide nuts, bolts washers, screws, and other fasteners with corrosion-resistant plated finish.

G. Electrodes for Welding: Comply with AWS Code and as recommended by stud manufacturer, and only as allowed by DEN Project Manager. Reference Section 050510 "Welding" for general welding requirements.

H. Galvanizing Repair: Where galvanized surfaces are damaged, prepare surfaces and repair in accordance with procedures specified in ASTM A 780.
1. Section Properties: <Insert minimum allowable calculated section modulus, moment of inertia, and allowable moment.>

2.4 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Section Properties: Per Schedule.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Flange Width: Per Schedule.

C. Vertical Deflection Clips: Manufacturer's standard head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AllSteel & Gypsum Products, Inc.
b. ClarkWestern Bulding Systems, Inc.
c. Dietrich Metal Framing; a Worthington Industries Company.
d. Marino/WARE.
e. SCAFCO Corporation
f. Steeler, Inc.
g. The Steel Network, Inc.
h. or approved equal.

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch (1.37 mm).
2. Flange Width: 3 inch.

2.5 CEILING JOIST FRAMING

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths

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indicated, unpunched with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
2. Flange Width: 1-5/8 inches (41 mm).

2.6 SOFFIT FRAMING

A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
2. Flange Width: 1-5/8 inches (41 mm).

2.7 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole reinforcing plates.
11. Backer plates.

2.8 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 36 55, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.

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D. Powder-Actuated Anchors: Powder-actuated anchors are not permitted and shall not be used.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.9 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780.

B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, Portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.

D. Shims: Load bearing, high-density multimonomer plastic, nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.10 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.

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4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install load bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets at the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Reference Section 050510 "Welding" for general welding requirements.

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B. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

C. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.

D. Powder-actuated fasteners are not permitted and shall not be used.

E. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).

F. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

G. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

H. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

I. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

J. Install insulation, specified in Section 072100 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

K. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

L. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch (3 mm)

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from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

2. Bolt or weld wall panels (at both horizontal and vertical junctures) to produce flush, even, true to line joints.
3. Step in face and jog in alignment between panels not to exceed 1/16".

M. Runner Tracks: Install continuous tracks sized to match studs unless otherwise noted. Align tracks accurately to layout at base and tops of studs. Secure tracks as recommended by stud manufacturer for type of construction involved, except do not exceed 24" o.c. spacing for fasteners, or 16" o.c. for other types of attachment. Provide fasteners at corners and ends of tracks.

N. Where stud system abuts structural columns or walls, including masonry walls, anchor ends of stiffeners to supporting structure.

O. Install supplementary framing, blocking and bracing in metal framing system wherever walls or partitions are indicated to support fixtures, equipment, services, casework, heavy trim railings and furnishings, and similar work requiring attachment to the wall or partition.

1. Where type of supplementary support is not otherwise indicated, comply with stud manufacturer's recommendations and industry standards in each case, considering weight or loading resulting from item supported. Provide horizontal stiffeners in stud system at 4'-6" O.C.

P. Installation of Wall Stud System: Secure studs to top and bottom runner tracks by either welding or screw fastening at both inside and outside flanges. Provide head slip connection.

Q. Frame wall openings larger than 2' 0" square with double stud at each jamb of frame except where more than 2 are either shown or indicated in manufacturer's instructions. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with stud shoes or by welding, and space jack studs same as full height studs of wall. Secure stud system wall opening frame in manner indicated.

R. Frame both sides of expansion and control joints, with separate studs; do not bridge the joint with components of stud system.

S. Install horizontal stiffeners in stud system, spaced (vertical distance) at not more than 4' 6" o.c. Weld at each intersection.

T. Field Painting: Touch up shop applied protective coatings damaged during handling and installation. Use compatible primer for prime coated surfaces; use galvanizing repair paint for galvanized surfaces.

3.4 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

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B. Fasten both flanges of studs to top andbottom track, unless otherwise indicated. Space studs as follows:

1. Stud Spacing: As indicated.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to bypassing studs and anchor to building structure.
4. Connect drift clips to cold formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches (1220 mm) apart. Fasten at each stud intersection.

1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 18 inches (450 mm) of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.

   a. Install solid blocking at 96-inch (2440-mm) centers.

2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
4. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

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1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.

C. Space joists not more than 2 inches (51 mm) from abutting walls, and as follows:

1. Joist Spacing: As indicated.

D. Frame openings with built-up joist headers consisting of joist and joist track, or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated.

1. Install web stiffeners to transfer axial loads of walls above.

F. Install bridging at intervals indicated. Fasten bridging at each joist intersection as follows:

1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.6 FIELD QUALITY CONTROL

A. Testing: Owner will Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and DEN Project Manager.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

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3.7 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

A. No separate measurement will 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 054000

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SECTION 055000 - METAL FABRICATIONS

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. Steel framing and supports for overhead doors.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Shelf angles.
4. Structural-steel door frames.
5. Other miscellaneous, non-structural framing as shown on the drawings or required for the bracing or support of the work of other Sections.
6. Anchors, fasteners, and related hardware or accessories required for the installation of work specified herein.

B. Products furnished, but not installed, under this Section:

C. Related Sections:
1. Section 051200 "Structural Steel Framing."
2. Section 055213 "Pipe and Tube Railings."

1.3 ACTION SUBMITTALS

A. Product Data: For the following:
1. Paint products.
2. Grout.
3. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

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1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.5 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".

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, and anchor bolts. Deliver such items to Project site in time for installation.

1.9 DELIVERY, STORAGE AND HANDLING

A. Storage: Store materials and fabrications in protected areas. Protect from rusting or other damage.

B. Identification: Properly identify all items or components, including bolts or other loose materials and accessories. Leave manufacturer's labels or tags intact on manufactured products.

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PART 2 - PRODUCTS

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Fasteners, General:

1. Use same material and finish as parts being joined, except use stainless steel between dissimilar metals and non-corrosive fasteners at exterior connections or joints.
2. Provide fasteners of sufficient strength to support connected members and loads, and to develop full strength of parts fastened or connected.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 325, Type 3 (ASTM A 325M, Type 3); with hex nuts, ASTM A 563, Grade C3 (ASTM A 563M, Class 8S3); and, where indicated, flat washers.

D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers; Alloy Group 1 (A1).

E. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Eyebolts: ASTM A 489.

G. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).

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H. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).

I. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).

J. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).

K. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

L. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F 2329.

M. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.

2.4 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Shop Primers: Provide primers that comply with Section 099123 Interior Painting

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it, liquid organic zinc compound containing not less than 95% pure zinc metal.

1. Subject to compliance with requirements, provide one of the following:

a. ZRC Products Co. "Z.R.C. Cold Galvanizing Compound".
b. <**Insert manufacturer's name**>
c. or approved equal.

D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION, GENERAL

A. Fabricate work to sizes, shapes, and profiles shown, and in accordance with approved shop drawings. Verify all dimensions prior to fabrication.

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B. Fabricate equipment supports and other items penetrating through roof from square, rectangular, or round tubing; angle, channel, or H-shapes will not be permitted.

C. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

D. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

E. Do all punching, shearing, cutting, and forming so as to produce clean, true lines, and surfaces with a constant width on each face. Form straight and true edge arises and uniform contours as detailed. Make stampings and perforations with uniformly spaced and sized openings in alignment in both directions. Dress all cuts smooth; make corners square and joints tight.

F. Uniformly space and align members. Provide sleeves, inserts, anchors, and other built-in and auxiliary work. Provide welded connections at all joints and intersections; use continuous welds and grind smooth.

G. Exposed-to-Public-View Members:

1. Fabricate items that will be exposed to public view with smooth, flat surfaces, free from embedded scale, marks, gouges, or other irregularities.
2. Form exposed work with accurate angles and surfaces and straight edges.
3. Fill depressions with weld metal of same composition as parent metal. Grind welds and raised marks flush with adjacent surfaces. Fill small pit marks with metallic compound and grind smooth.

H. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

I. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

J. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

K. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

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L. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.7 MANUFACTURED PRODUCTS

2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.
2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Hot-dip galvanize shelf angles located in exterior walls.

D. Prime shelf angles located in interior walls with zinc-rich primer.

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.9 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel doorframes from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch (16-by-38-mm) steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches (250 mm) o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

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1. Provide with integrally welded steel strap anchors for securing doorframes into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Hot-dip galvanize exterior steel frames.

D. Prime interior steel frames with zinc-rich primer

2.10 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.11 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.12 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Section 099123 "Interior Painting" unless zinc-rich primer is indicated.

C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

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1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work of this Section will be performed.

B. Do not proceed with the work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions

3.2 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Install metal fabrications in accordance with approved shop drawings.

C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

D. Field Welding: Comply with the following requirements:

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. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

F. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction. Remove all temporary braces or erection clips when no longer needed and restore affected surface finishes.

G. Insulate between dissimilar metals at connections.

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3.3 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

C.

3.4 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 FIELD QUALITY CONTROL

A. Visual Inspection: The testing and inspection agency will visually inspect shop and field welding and bolting of handrails, ladders, and other items requiring structural connections. Welds or bolts that do not pass visual inspection will be tested as specified herein at the Contractor's expense.

B. Welding Materials and Procedures

1. Verify that electrodes used for manual shielded metal-arc welding conform to requirements of the Contract Documents, and that welding procedures and welding sequences are followed without deviation.
2. Verify certification of welding operators under AWS qualification procedures within previous twelve (12) months.
3. Verify that fit up, joint preparation, size, contour, extent of reinforcement, and length and location of welds conform to specified requirements.
4. Inspect and test field welds as follows:

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a. Visually inspect all (100%) welds.
b. If more than 10% of the tested welds of any type are rejected, an additional 10% of all such welds will be re-tested using the same test method. This 10% additional testing procedure will be continued until the rejection rate drops below 10%.
c. In addition, the DEN Project Manager reserves the right to require additional ultrasonic or magnetic testing of uninspected welds of the same type.

1) All costs of additional testing shall be borne by the Contractor.

d. Radiographic (X-ray) testing (ASTM E94 and E390) may be substituted for ultrasonic testing at the option of the testing agency and with the approval of the DEN Project Manager.

5. Authority for Rejection: The testing and inspections agency is authorized to reject welding materials and procedures. Rejection may be based on visual inspection if, in the opinion of the inspector, the weld would not pass a more detailed investigation.

3.6 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil (0.05-mm) dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Interior Painting."

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.7 PROTECTION

A. Protection of Work in Place: Protect all work in place, and replace damaged finished work without cost to Owner.

B. Touch-up and Repair of Galvanized Coating:

1. Welds: Wire brush to remove slag residue, weld splatter, and similar deleterious materials. If surface is oily, clean with phosphoric acid base compound as recommended by galvanizing repair compound manufacturer. Apply galvanizing repair compound in accordance with manufacturer's instructions.
2. Scratches and Other Surface Damage: Thoroughly wash damaged area with water or mild detergent to remove any zinc oxides that may have formed. Apply galvanizing repair compound in accordance with manufacturer's instructions.

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PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 055000

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SECTION 055113 - METAL PAN STAIRS

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. Preassembled steel stairs with concrete-filled treads.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
2. Section 055213 "Pipe and Tube Railings" for pipe and tube railings.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Coordinate locations of hanger rods and struts with other work so that they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

1.4 ACTION SUBMITTALS

A. Product Data: For metal pan stairs and the following:
1. Nonslip aggregates and nonslip-aggregate finishes.
2. Abrasive nosings.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

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C. Samples for Verification: For each type and finish of nosing and tread.

D. Delegated-Design Submittal: For stairs and railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs and railings.

B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms, and framing members to [L/360] <Insert deflection ratio> or 1/4 inch whichever is less.

6. Infill of Guards:

a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
b. Infill load and other loads need not be assumed to act concurrently.

C. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 “Minimum Design Loads for Buildings and Other Structures”: Section 9, “Earthquake Loads”.

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2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Sustainable Design Requirements:

C. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.

E. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

F. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25 unless another grade is required by design loads; exposed.

G. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30 unless another grade is required by design loads.

H. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 coating,[either commercial steel, Type B, or] structural steel, Grade 33 unless another grade is required by design loads.

2.3 ABRASIVE NOSINGS

A. Cast-Metal Units: Cast iron, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.
   1. Configuration: Cross-hatched units, 3 inches wide without lip.

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Apply bituminous paint to concealed surfaces of cast-metal units set into concrete.

D. Apply clear lacquer to concealed surfaces of extruded units set into concrete.

2.4 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

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C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for exterior stairs.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy [Group 1 (A1)] [Group 2 (A4)] stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.5 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099123 "Interior Painting."

B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

D. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.

E. Nonslip-Aggregate Concrete Finish: Factory-packaged abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.

F. Welded Wire Reinforcement: ASTM A 185/A 185M, 6 by 6 inches W1.4 by W1.4, unless otherwise indicated.

2.6 FABRICATION, GENERAL

A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.
2. Use connections that maintain structural value of joined pieces.

B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

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C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld connections to comply 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. Weld exposed corners and seams continuously unless otherwise indicated.
5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 3 welds: partially dressed weld with spatter removed

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

2.7 STEEL-FRAMED STAIRS

A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Commercial Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel plates or channels.

    a. Provide closures for exposed ends of channel stringers.

2. Construct platforms of steel plate or channel headers and miscellaneous framing members as needed to comply with performance requirements.
3. Weld or bolt stringers to headers; weld[or bolt] framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.
5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

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C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.067 inch or as indicated on Drawings.

1. Steel Sheet: Uncoated cold-rolled steel sheet.
2. Directly weld metal pans to stringers; locate welds on top of subtreads where they are concealed by concrete fill. Do not weld risers to stringers.
3. Attach abrasive nosings to risers.
4. At Contractor's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.

a. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

D. Abrasive-Coating-Finished, Formed-Metal Stairs: Form risers, treads, and platforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.097 inch.

1. Steel Sheet: Uncoated hot-rolled steel sheet unless otherwise indicated.
2. Directly weld risers and treads to stringers; locate welds on underside of stairs.
3. Provide platforms of configuration indicated or, if not indicated, the same as treads. Weld platforms to platform framing.
4. Finish tread and platform surfaces with manufacturer's standard epoxy-bonded abrasive finish.

2.8 STAIR RAILINGS

A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."

2.9 FINISHES

A. Finish metal stairs after assembly.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."

D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

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PART 3 - EXECUTION

3.1 INSTALLING METAL PAN STAIRS

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

G. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."

1. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.

H. Install precast concrete treads with adhesive supplied by manufacturer.

3.2 ADJUSTING AND CLEANING

A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Interior Painting."

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

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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 055113

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SECTION 055213 - PIPE AND TUBE RAILINGS

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. Steel pipe and tube railings.

B. Related Requirements:

1. Section 055113 "Metal Pan Stairs" for steel tube railings associated with metal pan stairs.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Railing brackets.
3. Grout, anchoring cement, and paint products.

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B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
2. Fittings and brackets.
3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.

a. Show method of connecting and finishing members at intersections.

D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Mill Certificates: Signed by manufacturers of stainless-steel products certifying that products furnished comply with requirements.

D. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

E. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design railings, including attachment to building construction.

B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:

   a. Uniform load of 50 lbf/ ft. (0.73 kN/m) applied in any direction.
   b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
   c. Uniform and concentrated loads need not be assumed to act concurrently.

2. Infill of Guards:

   a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
   b. Infill load and other loads need not be assumed to act concurrently.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C),material surfaces.

2.3 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.

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2.4 STEEL AND IRON

A. Tubing:ASTM A 500 (cold formed) or ASTM A 513.

B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

D. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.5 FASTENERS

A. General: Provide the following:
1. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
2. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
3. Provide tamper-resistant flat-head machine screws for exposed fasteners unless otherwise indicated.

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
1. Material for Exterior Locations : Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.6 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

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B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.

C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

F. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.7 FABRICATION

A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.

G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.

H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

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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 flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.

J. Form Changes in Direction as Follows:

1. As detailed.
2. By bending or by inserting prefabricated elbow fittings.
3. By flush bends or by inserting prefabricated flush-elbow fittings.
4. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.

K. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

L. Close exposed ends of railing members with prefabricated end fittings.

M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.

N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.

O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

P. For railing posts set in concrete, provide steel sleeves not less than 6 inches (150 mm) long with inside dimensions not less than 1/2 inch (13 mm) greater than outside dimensions of post, with metal plate forming bottom closure.

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Q. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into 1-by-1/2-by-1/8-inch (25-by-13-by-3-mm) metal channel frames. Make wire mesh and frames from same metal as railings in which they are installed.

1. Orient wire mesh with as indicated on Drawings.

R. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.8 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize steel railings, including hardware, after fabrication.
2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
4. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).

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3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

3.4 ANCHORING POSTS

A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

B. Form or core-drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

C. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material attached to post with set screws.

D. Leave anchorage joint exposed with 1/8-inch (3-mm) buildup, sloped away from post.

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E. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
   1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

F. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.5 ATTACHING RAILINGS

A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends or connected to railing ends using nonwelded connections.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections.

C. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

D. Secure wall brackets and railing end flanges to building construction as follows:

   1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
   2. For hollow masonry anchorage, use toggle bolts.
   3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
   4. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.6 ADJUSTING AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

3.7 PROTECTION

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

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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 055213

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SECTION 072500 - WEATHER BARRIERS

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. Building wrap.
2. Flexible flashing.

B. Related Requirements:

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For building wrap, include data on air and water-vapor permeance based on testing according to referenced standards.
2. Include data substantiating that materials comply with specified requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For water-resistive barrier and flexible flashing, from ICC-ES.

1.5 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".

PART 2 - PRODUCTS

2.1 WATER-RESISTIVE BARRIER

A. Building Wrap: ASTM E 1677, Type I air barrier; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to

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ASTM E 84; UV stabilized; and acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Dow Chemical Company (The); Styrofoam Weathermate Plus Brand Housewrap.
    b. DuPont (E. I. du Pont de Nemours and Company); Tyvek CommercialWrap.
    c. Pactiv, Inc.; GreenGuard Ultra Wrap.
    d. Raven Industries Inc.; Fortress Pro Weather Protective Barrier.
    e. or approved equal.

2. Water-Vapor Permeance: Not less than 50 g through 1 sq. m of surface in 24 hours per ASTM E 96/E 96M, Desiccant Method (Procedure A).
3. Air Permeance: Not more than 0.004 cfm/sq. ft. at 0.3-inch wg (0.02 L/s x sq. m at 75 Pa) when tested according to ASTM E 2178.
4. Allowable UV Exposure Time: Not less than three months.

B. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

2.2 MISCELLANEOUS MATERIALS

A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than =[0.025 inch (0.6 mm).

1. Products: Subject to compliance with requirements, provide one of the following:

    a. DuPont (E. I. du Pont de Nemours and Company); DuPont Flashing Tape.
    b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Vycor Butyl Self Adhered Flashing.
    c. Protecto Wrap Company; BT-25 XL.
    d. Raven Industries Inc.; Fortress Flashshield.
    e. Advanced Building Products Inc.; Wind-o-wrap.
    f. Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
    g. Fiberweb, Clark Hammerbeam Corp.; Aquaflash 500.
    h. Fortifiber Building Systems Group; Fortiflash 40].
    i. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; [Vycor V40 Self-Adhered Flashing.
    j. MFM Building Products Corp.; Window Wrap.
    k. Polyguard Products, Inc.; [Polyguard JT-30 Tape.
    l. Sandell Manufacturing Co., Inc.; Presto-Seal.
    m. or approved equal.

B. Primer for Flexible Flashing: Product recommended by manufacturer of flexible flashing for substrate.

C. Nails and Staples: ASTM F 1667.

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PART 3 - EXECUTION

3.1 WATER-RESISTIVE BARRIER INSTALLATION

A. Cover exposed exterior surface of sheathing with water-resistive barrier securely fastened to framing immediately after sheathing is installed.

B. Cover sheathing with water-resistive barrier as follows:

1. Cut back barrier 1/2 inch (13 mm) on each side of the break in supporting members at expansion- or control-joint locations.
2. Apply barrier to cover vertical flashing with a minimum 4-inch (100-mm) overlap unless otherwise indicated.

C. Building Wrap: Comply with manufacturer's written instructions.

1. Seal seams, edges, fasteners, and penetrations with tape.
2. Extend into jambs of openings and seal corners with tape.

3.2 FLEXIBLE FLASHING INSTALLATION

A. Apply flexible flashing where indicated to comply with manufacturer's written instructions.

1. Prime substrates as recommended by flashing manufacturer.
2. Lap seams and junctures with other materials at least 4 inches (100 mm) except that at flashing flanges of other construction, laps need not exceed flange width.
3. Lap flashing over water-resistive barrier at bottom and sides of openings.
4. Lap water-resistive barrier over flashing at heads of openings.
5. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

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.

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END OF SECTION 072500

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SECTION 079200 - JOINT SEALANTS

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. Silicone joint sealants.
2. Urethane joint sealants.
3. Polysulfide joint sealants.
4. Latex joint sealants.
5. Solvent-release-curing joint sealants.
6. Preformed joint sealants.
7. Acoustical joint sealants.

B. Related Sections:
1. Section 092900 "Gypsum Board" for sealing perimeter joints.

1.3 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use manufacturer's standard test method to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than eight (8 pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

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B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by DIA Project Manager .
2. Conduct field tests for each application indicated below:

    a. Each kind of sealant and joint substrate indicated.

3. Notify DIA Project Manager seven (7) days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

    a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

        1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.4 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

1.5 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

1. Include data substantiating that materials comply with requirements.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

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D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and testing agency.

B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

C. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.

D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

E. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

F. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

G. Field-Adhesion Test Reports: For each sealant application tested.

H. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indi-cating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturer's written instructions to

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prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

D. Preinstallation Conference: Conduct conference at Project site.

1.10 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer[**or are below** 40 deg F (5 deg C)].
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.11 WARRANTY

A. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Minimum two (2) years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Minimum twenty (20) years from date of Substantial Completion.

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C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

C. Colors of Exposed Joint Sealants: As selected by DIA Project Manager from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 790.
b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
c. May National Associates, Inc.; Bondaflex Sil 290.
d. Pecora Corporation; 301 NS.
e. Sika Corporation, Construction Products Division; SikaSil-C990.
f. Tremco Incorporated; Spectrem 1.
g. or approved equal.

B. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

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a. BASF Building Systems; Omniseal 50.
b. Dow Corning Corporation; 756 SMS.
c. GE Advanced Materials - Silicones; SilGlaze II SCS2800.
d. May National Associates, Inc.; Bondaflex Sil 295.
e. Pecora Corporation; 864.
f. Polymeric Systems, Inc.; PSI-641.
g. Sika Corporation, Construction Products Division; SikaSil-C995.
h. Tremco Incorporated;Spectrem 2.
i. or approved equal.

C. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 799.
b. GE Advanced Materials - Silicones; UltraGlaze SSG4000.
c. May National Associates, Inc.; Bondaflex Sil 200 GPN.
d. Polymeric Systems, Inc.; PSI-631.
e. Schnee-Morehead, Inc.; SM5731 Poly-Glaze Plus.
f. Tremco Incorporated; Proglaze SSG.
g. or approved equal.

D. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Bostik, Inc.; Chem-Calk 1200.
b. Dow Corning Corporation; 999-A.
c. GE Advanced Materials - Silicones; Contractors SCS1000 .
d. May National Associates, Inc.; Sil 100 GC.
e. Pecora Corporation; 860.
f. Polymeric Systems, Inc.; PSI-601.
g. Schnee-Morehead, Inc.; SM5732 Polyglaze.
h. Tremco Incorporated;Proglaze.
i. or approved equal.

E. Single-Component, Nonsag, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 790.
b. May National Associates, Inc.; Bondaflex Sil 728 NS.
c. Pecora Corporation; 301 NS.
d. Tremco Incorporated; Spectrem 800.
e. or approved equal.

F. Single-Component, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade P, Class 100/50, for Use T.

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1. Products: Subject to compliance with requirements, provide one of the following:

    a. Dow Corning Corporation; 890-SL.
    b. May National Associates, Inc.; Bondaflex Sil 728 SG.
    c. Pecora Corporation; 300 SL.
    d. Tremco Incorporated; Spectrem 900 SL.
    e. or approved equal.

G. Multicomponent, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Tremco Incorporated; Spectrem 4TS.
    b. or approved equal.

H. Multicomponent, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade P, Class 100/50, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Dow Corning Corporation; FC Parking Structure Sealant.
    b. May National Associates, Inc.; Bondaflex Sil 728 RCS.
    c. or approved equal.

I. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Pecora Corporation; 898.
    b. or approved equal.

J. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. BASF Building Systems; Omniplus.
    b. Dow Corning Corporation; 786 Mildew Resistant.
    c. GE Advanced Materials - Silicones; Sanitary SCS1700.
    d. May National Associates, Inc.; Bondaflex Sil 100 WF.
    e. Tremco Incorporated; Tremsil 200 Sanitary.
    f. or approved equal.

2.3 URETHANE JOINT SEALANTS

A. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.

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1. Products: Subject to compliance with requirements, provide one of the following:

    a. Sika Corporation, Construction Products Division; Sikaflex - 15LM.
    b. Tremco Incorporated; Vulkem 921.
    c. or approved equal.

B. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Pacific Polymers International, Inc.; Elasto-Thane 230 LM Type II.
    b. Polymeric Systems, Inc.; PSI-901.
    c. or approved equal.

C. Single-Component, Nonsag, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. BASF Building Systems; Sonolastic NP1.
    b. Bostik, Inc.; Chem-Calk 900.
    c. May National Associates, Inc.; Bondaflex PUR 25.
    d. Pacific Polymers International, Inc.; Elasto-Thane 230 Type II.
    e. Pecora Corporation; Dynatrol I-XL.
    f. Polymeric Systems, Inc.; Flexiprene 1000.
    g. Schnee-Morehead, Inc.; Permathane SM7100.
    h. Sika Corporation, Construction Products Division; Sikaflex - 1a.
    i. Tremco Incorporated;Dymonic.
    j. or approved equal.

D. Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920. Type S, Grade NS, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. BASF Building Systems; Sonolastic Ultra.
    b. May National Associates, Inc.; Bondaflex PUR 40 FC.
    c. Pacific Polymers International, Inc.; Elasto-Thane 230 Type II.
    d. Sika Corporation, Construction Products Division; Sikaflex - 1a.
    e. Tremco Incorporated; Vulkem 116.
    f. or approved equal.

E. Single-Component, Pourable, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. BASF Building Systems; Sonolastic SL 1.
    b. Bostik, Inc.; Chem-Calk 950.
    c. May National Associates, Inc.; Bondaflex PUR 35 SL.

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d. Pecora Corporation; Urexpan NR-201.
e. Polymeric Systems, Inc.; Flexiprene 952.
f. Schnee-Morehead, Inc.; Permathane SM7101.
g. Sika Corporation. Construction Products Division; Sikaflex - 1CSL.
h. Tremco Incorporated; Vulkem 45.
i. or approved equal.

F. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pecora Corporation; Dynatrol II.
b. Polymeric Systems, Inc.; PSI-270.
c. Tremco Incorporated; Dymeric 240.
d. or approved equal.

G. Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Building Systems; Sonolastic NP 2.
b. Bostik, Inc.; Chem-Calk 500.
c. May National Associates, Inc.; Bondaflex PUR 2 NS.
d. Pacific Polymers International, Inc.; Elasto-Thane 227 High Shore Type II.
e. Pecora Corporation; Dynatred.
f. Sika Corporation, Construction Products Division; Sikaflex - 2c NS.
g. Tremco Incorporated; Vulkem 227.
h. or approved equal.

H. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Polymeric Systems, Inc.; PSI-270.
b. Tremco Incorporated; Dymeric 240 FC.
c. or approved equal.

I. Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Building Systems; Sonolastic NP 2.
b. LymTal International, Inc.; Iso-Flex 885 SG.
c. May National Associates, Inc.; Bondaflex PUR 2 NS.
d. Pacific Polymers International, Inc.; Elasto-Thane 227 High Shore Type II.
e. Pecora Corporation; Dynatred.
f. Sika Corporation, Construction Products Division; Sikaflex - 2c NS.

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g. Tremco Incorporated; Vulkem 227.
h. or approved equal.

2.4 POLYSULFIDE JOINT SEALANTS

A. Single-Component, Nonsag, Polysulfide Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pacific Polymers International, Inc.; Elastoseal 230 Type I.
b. W. R. Meadows, Inc.; Deck-O-Seal One Step.
c. or approved equal.

B. Multicomponent, Nonsag, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Building Systems; Sonolastic Polysulfide Sealant.
b. Pacific Polymers International, Inc.; Elasto-Seal 227 Type II.
c. Pecora Corporation; Synthacalk GC-2+.
d. W. R. Meadows, Inc.; Deck-O-Seal Gun Grade.
e. or approved equal.

C. Multicomponent, Nonsag, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Building Systems; Sonolastic Polysulfide Sealant.
b. Pecora Corporation; Synthacalk GC-2+.
c. or approved equal.

D. Multicomponent, Pourable, Traffic-Grade, Polysulfide Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pacific Polymers International, Inc.; Elastoseal 227 Type I.
b. W. R. Meadows, Inc.; Deck-O-Seal 125.
c. or approved equal.

2.5 LATEX JOINT SEALANTS

A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Products: Subject to compliance with requirements, provide one of the following:

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a. BASF Building Systems; Sonolac.
b. Bostik, Inc.; Chem-Calk 600.
c. May National Associates, Inc.; Bondaflex 600.
d. Pecora Corporation; AC-20+.
e. Schnee-Morehead, Inc.; SM 8200.
f. Tremco Incorporated; Tremflex 834.
g. or approved equal.

2.6 ACOUSTICAL JOINT SEALANTS

A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Pecora Corporation; AC-20 FTR.
b. USG Corporation; SHEETROCK Acoustical Sealant.
c. or approved equal.

2.7 JOINT SEALANT BACKING

A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.8 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances

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capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

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C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

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G. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency acceptable to the Owner to perform field tests and inspections, and prepare reports.

B. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

   a. Perform 10 tests for the first 1000 feet (300 m) > of joint length for each kind of sealant and joint substrate.
   b. Perform 1 test for each 1000 feet (300 m) of joint length thereafter or 1 test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

   a. Whether sealants filled joint cavities and are free of voids.
   b. Whether sealant dimensions and configurations comply with specified requirements.
   c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

C. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered

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satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

    a. Construction joints in cast-in-place concrete.
    b. Joints between metal panels.
    c. Joints between different materials listed above.
    d. Perimeter joints between materials listed above and frames of doors windows and louvers.
    e. Control and expansion joints in ceilings and other overhead surfaces.
    f. Other joints as indicated.

2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 100/50.
3. Urethane Joint Sealant: Single component, nonsag, Class 100/50] [Single component, nonsag, Class 50.
4. Preformed Joint Sealant: Preformed silicone.
5. Joint-Sealant Color: As selected by DIA Project Manager from manufacturer's full range of colors.

B. Joint-Sealant Application: Interior joints in horizontal traffic surfaces

1. Joint Locations:

    a. Isolation joints in cast-in-place concrete slabs.
    b. Other joints as indicated.

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2. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing.
3. Urethane Joint Sealant: Single component, nonsag, traffic grade.
4. Polysulfide Joint Sealant: Multicomponent, nonsag, traffic grade.
5. Preformed Joint Sealant: Preformed foam.
6. Joint-Sealant Color: As selected by DIA Project Manager from manufacturer's full range of colors

C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces

1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Perimeter joints of exterior openings where indicated.
c. Tile control and expansion joints.
d. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
e. Other joints as indicated.

2. Joint Sealant: Latex.
3. Joint-Sealant Color: As selected by DIA Project Manager from manufacturer's full range of colors.

D. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces

1. Joint Location:

a. Acoustical joints where indicated.
b. Other joints as indicated.

2. Joint Sealant: Acoustical.
3. Joint-Sealant Color: As selected by DIA Project Manager from manufacturer's full range.

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.

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END OF SECTION 079200

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SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

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 hollow-metal doors and frames.

B. Related Requirements:
   1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

B. Coordinate shop drawings, fabrication and delivery of welded frames with project schedule and installation of wall systems and other systems.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at at time and location as determined by DIA Project Manager.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.
   2. Include data substantiating that materials comply with requirements.

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B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

C. Samples for Verification:

1. For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 127 mm).
2. For "Doors" and "Frames" subparagraphs below, prepare Samples approximately 12 by 12 inches (305 by 305 mm to demonstrate compliance with requirements for quality of materials and construction:

   a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
   b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

D. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.7 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

B. Warranty: Submit copy of product warranties.

1.8 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".

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1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch- (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ceco Door Products; an Assa Abloy Group company.
2. Colorado Doorways
3. Gateway
4. NCS Manufacturing Co.
5. Southwestern Hollow Metal.
6. Steelcraft; an Ingersoll-Rand company.
7. vor approved equal.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.3 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and

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clearances, and as specified.

1. Heavy-Duty Doors and Frames: SDI A250.8, Level 2. [At locations indicated in the Door and Frame SchedulePhysical Performance: Level B according to SDI A250.4.
2. Doors:

    a. Type: As indicated in the Door and Frame Schedule.
    b. Thickness: 1-3/4 inches (44.5 mm).
    c. Face: Uncoated, cold-rolled steel sheet, minimum thickness of 0.042 inch (1.0 mm).
    d. Edge Construction:Model 1, Full FlushCore: [Vertical steel stiffeners].

        1) Fire Door Cores: As required and approved to provide fire-protection and temperature-rise ratings indicated.

3. Frames:

    a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).
    b. Construction: Face welded.

4. Exposed Finish: Prime .

2.4 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

A. Construct exterior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Maximum-Duty Doors and Frames: SDI A250.8, Level 4. At locations indicated in the Door and Frame Schedule.

1. Physical Performance: Level A according to SDI A250.4.
2. Doors:

    a. Type: As indicated in the Door and Frame Schedule.
    b. Thickness: 1-3/4 inches (44.5 mm.)
    c. Face: Metallic-coated steel sheet, minimum thickness of 0.067 inch (1.7 mm), with minimum A40 (ZF120) coating.
    d. Edge Construction:Model 1, Full Flush.
    e. Core: Provide thermal-resistance-rated, steel-reinforced cores for exterior doors.

        1) Steel-reinforced core: 0.026-inch (0.7-mm-) thick, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart, spot-welded to face sheets at a maximum of 5 inches (127 mm0 o.c. Spaces filled snugly between stiffeners with polystyrene insulation.

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2.5 FRAME ANCHORS

A. Jamb Anchors:
   1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch (1.0 mm), and as follows:

   1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
   2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at finish floor surface.

2.6 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

   1. Power-actuated fasteners shall be used only with prior approval by DIA Project Manager.

G. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

H. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

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2.7 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow-Metal Doors:

1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch (0.66 mm), steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches (152 mm) apart. Spot weld to face sheets no more than 5 inches (127 mm) o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
2. Fire Door Cores: As required to provide fire-protection[and temperature-rise] ratings indicated.
3. Vertical Edges for Single-Acting Doors: Bevel edges 1/8 inch in 2 inches (3.2 mm in 51 mm) .
4. Top Edge Closures: Close top edges of doors with inverted closures of same material as face sheets.
5. Bottom Edge Closures: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.

D. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
1. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
2. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

1) Three anchors per jamb up to 60 inches (1524 mm) high.
2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.

b. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

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a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

E. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

2.8 STEEL FINISHES

A. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with SDI A250.3.

1. Color and Gloss: Match DIA Project Manager's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

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3.3 INSTALLATION

A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install door silencers in frames before grouting.
    d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    e. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    f. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

    a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

        1) Powder-actuated fasteners shall be used only with prior approval by DIA Project Manager

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
5. In-Place Metal -Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.
6. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

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C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

a. Between Door and Frame Jambs and Head: 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).
b. Between Edges of Pairs of Doors: 1/8 inch (3.2 mm) to 1/4 inch (6.3 mm) plus or minus 1/32 inch (0.8 mm).
c. At Bottom of Door: 3/4 inch (19.1 mm.
d. Between Door Face and Stop: 1/16 inch (1.6 mm) to 1/8 inch (3.2 mm) plus or minus 1/32 inch (0.8 mm).

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

F. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

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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 081113

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SECTION 083323 - OVERHEAD COILING DOORS

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. Service doors.

B. Related Sections:
1. Section 099123 "Interior Painting" for finish painting of factory-primed doors.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design overhead coiling doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory. Include the following:

1. Construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required

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clearances, method of field assembly, components, and location and size of each field connection.
2. Show locations of replaceable fusible links.
3. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Curtain Slats: 12 inches (305 mm) long
2. Bottom Bar: 6 inches (150 mm) long with sensor edge.
3. Guides: 6 inches (150 mm) long.
4. Brackets: 6 inches (150 mm) square.
5. Hood: 6 inches (150 mm) square.

E. Delegated-Design Submittal: For overhead coiling doors 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 seismic restraints.
2. Summary of forces and loads on walls and jambs.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification Certificates: For overhead coiling doors, accessories, and components, from manufacturer.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For overhead coiling doors to include in 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".

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

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1. Obtain operators and controls from overhead coiling door manufacturer.

C. 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.

D. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

PART 2 - PRODUCTS

2.1 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural steel sheet; complying with ASTM A 653/A 653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch (0.71 mm) and as required to meet requirements.
2. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face.

B. Endlocks for Service Doors: Malleable-iron casings galvanized after fabrication, secured to curtain slats with galvanized rivets or high-strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.

C. Bottom Bar for Service Doors: Consisting of two angles, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3 mm) thick; fabricated from manufacturer's standard hot-dip galvanized steel, stainless steel, or aluminum extrusions to match curtain slats and finish.

D. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

1. Removable Posts and Jamb Guides for Counter Doors: Manufacturer's standard.

2.2 HOOD

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-

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mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Galvanized Steel: Nominal 0.028-inch- (0.71-mm-) thick, hot-dip galvanized steel sheet with G90 (Z275) zinc coating, complying with ASTM A 653/A 653M.

2.3 LOCKING DEVICES

A. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

1. Lock Cylinders: Provide standard with manufacturer and keyed to building keying system.
2. Keys: Provide three for each cylinder.

B. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.4 CURTAIN ACCESSORIES

A. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

1. Provide pull-down straps or pole hooks for doors more than 84 inches (2130 mm) high.

2.5 COUNTERBALANCING MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of manufacturer's standard hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.

C. Spring Balance: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

D. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

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E. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.6 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24 V, ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door Operator Location(s): Operator location indicated for each door.
1. Front-of-Hood Mounted: Operator is mounted to the right or left door head plate with the operator on coil side of the door-hood assembly and connected to the door drive shaft with drive chain and sprockets. Front clearance is required for this type of mounting.

D. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 110513 "Common Motor Requirements for Equipment" unless otherwise indicated.

1. Electrical Characteristics:

   a. Phase: Single phase.
   b. Volts: 208 V.
   c. Hertz: 60.

2. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
3. Motor Size: Minimum size as indicated. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. (203 mm/s) and not more than 12 in./sec. (305 mm/s), without exceeding nameplate ratings or service factor.
4. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
5. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

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F. Obstruction Detection Device: Equip motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.

1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.

    a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.

2. Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

    a. Self-Monitoring Type: Four-wire configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.

G. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."

1. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.

H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf (111 N)

I. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.

L. Radio-Control System: Consisting of the following:

1. Three-channel universal coaxial receiver to open, close, and stop door; one per operator.
2. Multifunction remote control.
3. Remote-antenna mounting kit.

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2.7 DOOR ASSEMBLY

A. Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ACME Rolling Doors.
b. Alpine Overhead Doors, Inc.
c. AlumaTek, Inc.
d. C.H.I. Overhead Doors.
e. City-Gates.
f. Cookson Company.
g. Cornell Iron Works, Inc.
h. Dynamic Closures Corp.
i. Lawrence Roll-Up Doors, Inc.
j. Mahon Door Corporation.
k. McKeon Rolling Steel Door Company, Inc.
l. Metro Door.
m. Overhead Door Corporation.
n. QMI Security Solutions.
o. Raynor.
p. Southwestern Steel Rolling Door Co.
q. Wayne-Dalton Corp.
r. Windsor Door.
s. <Insert manufacturer's name>.
t. or approved equal.

B. Operation Cycles: Not less than 20,000.

1. Include tamperproof cycle counter.

C. Door Curtain Material: Galvanized steel.

D. Door Curtain Slats: Flat profile slats of 1-1/4-inch (32-mm) > center-to-center height.

E. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise. Provide removable post(s) and jamb guides where shown on Drawings.

F. Hood: Match curtain material and finish.

1. Shape: Round unless otherwise shown on Drawings <Insert shape>.
2. Mounting: Between jambs.

G. Electric Door Operator:

1. Usage Classification: Medium duty, up to 15 cycles per hour.

2. Remote-Control Station: Where shown on Drawings.

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3. Other Equipment: Audible and visual signals .

H. Door Finish:
1. Factory Prime Finish: Manufacturer's standard color.

2.8 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 STEEL AND GALVANIZED-STEEL FINISHES

A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, and operators at the mounting locations indicated for each door.

C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

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3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Test door closing when activated by detector or alarm-connected fire-release system. Reset door-closing mechanism after successful test.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide weathertight fit around entire perimeter.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

1. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

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 083323

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SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series
2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door

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Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

3. Content: Include the following information:

    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.
    h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

D. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.

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1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

F. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.

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4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures

H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

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C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:
1. Seven years for heavy duty cylindrical (bored) locks and latches.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

a. Two Hinges: For doors with heights up to 60 inches.
b. Three Hinges: For doors with heights 61 to 90 inches.
c. Four Hinges: For doors with heights 91 to 120 inches.
d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

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2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

    a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
    b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

    a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
    b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

    a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

    a. Hager Companies (HA).

2.3 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

B. Cylinders: Original manufacturer cylinders complying with the following:

1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
5. Keyway: Match Facility Restricted Keyway.

C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:

1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.

D. Patented Cylinders: ANSI/BHMA A156.5, Grade 1, certified patented cylinders employing a utility patented and restricted keyway requiring the use of a patented key. Cylinders are to be protected from unauthorized manufacture and distribution by manufacturer’s United States patents. Cylinders are to be factory keyed with owner having the ability for on-site original key cutting.

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1. Manufacturers:

    a. Medeco (MC) - X4 Series.
    b. No Substitution.

E. Keying System: Each type of lock and cylinders to be factory keyed.

1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Key locks to Owner's existing system.

F. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)
2. Master Keys (per Master Key Level/Group): Five (5).
3. Construction Keys (where required): Ten (10).
4. Construction Control Keys (where required): Two (2).
5. Permanent Control Keys (where required): Two (2).

G. Construction Keying: Provide temporary keyed construction cores.

2.4 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Manufacturers:

    a. Sargent Manufacturing (SA) – 8200 Series.
    b. Stanley Best (BE) – 40H-UN Series.

2.5 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

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1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.6 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.

3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.

4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

6. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

7. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.

8. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

9. Rail Sizing: Provide exit device rails factory sized for proper door width application.

10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

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B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

1. Manufacturers:

a. Von Duprin (VD) - 35A/98 XP Series.
b. No Substitution.

2.7 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.

2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.

4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.

5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.

1. Manufacturers:

a. Norton Door Controls (NO) - 7500 Series.
b. No Substitution.

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2.8 ARCHITECTURAL TRIM

A. Door Protective Trim
1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1” LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16” above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer’s catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
    a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
    a. Baldwin Hardware Corporation.
    b. Burns Manufacturing (BU).
    c. Don-Jo Mfg., Inc.
    d. Hager Companies (HA).
    e. Hiawatha, Inc. (HI).
    f. IPC Door and Wall Protection Systems, Inc.; Div. of InPro Corporation.
    g. Ives (IV).
    h. Pawling Corporation.
    i. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
    j. Trimco (TC).

2.9 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
1. Manufacturers:
    a. Burns Manufacturing (BU).
    b. Hager Companies (HA).
    c. Hiawatha, Inc. (HI).
    d. Ives (IV).
    e. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
    f. Trimco (TC).

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2.10 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:
1. M-D Building Products, Inc.
2. National Guard Products (NG).
3. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
4. Reese Enterprises, Inc. (RE).
5. Sealeze; a unit of Jason Incorporated.
6. Zero (ZE).

2.11 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.12 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

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C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.13 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.14 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

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1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

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B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.

C. Manufacturer’s Abbreviations:

1. HA - Hager
2. SA - Sargent
3. VD - Von Duprin
4. MC - Medeco
5. NO - Norton
6. RO - Rockwood
7. PE - Pemko

Hardware Sets

Set: 1.0
Doors: CCA_00_4C_016A, CCA_00_4C_016B, CCA_00_4C_016C, CCC_00_4C_016A, CCC_00_4C_016B, CCC_00_4C_016C

6	Hinge	BB1168 (NRP)	US26D	HA
1	Concealed Vert Rod Exit	9847EO	US32D	VD
1	Concealed Vert Rod Exit	9847L 996L(Std)	US32D	VD
1	Cylinder	Match existing X4 SFIC	26	MC
2	Surface Closer	CLP7500	689	NO
2	Kick Plate	K1050 10" CSK	US32D	RO
1	Gasketing	S88D		PE
2	Meeting Stile Seal	305CN		PE

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Set: 2.0
Doors: CCA_00_4C_016E

3	Hinge	BB1168 (NRP)	US26D	HA
1	Rim Exit Device	98L 996L(Std)	US32D	VD
1	Cylinder	Match existing X4 SFIC	26	MC
1	Surface Closer	CLP7500	689	NO
1	Kick Plate	K1050 10" CSK	US32D	RO
1	Gasketing	S88D		PE

Set: 3.0
Doors: CCA_00_4C_016D, CCC_00_4C_016D

3	Hinge	BB1279 (NRP)	US26D	HA
1	Storeroom Lock	72 8204 LL	US26D	SA
1	Small Format Inter Core	Match existing X4	26	MC
1	Surface Closer	CLP7500	689	NO
1	Kick Plate	K1050 10" CSK	US32D	RO
1	Gasketing	S88D		PE

END OF SECTION 087100

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SECTION 089000 - LOUVERS AND VENTS

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. Adjustable, extruded-aluminum louvers.

B. Related Sections:
   1. Division 23 Sections for control systems for louvers and vents.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades; i.e., the axes of the blades are horizontal.

C. Vertical Louver: Louver with vertical blades; i.e., the axes of the blades are vertical.

D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

E. Storm-Resistant Louver: Louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

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1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
2. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.
2. Show mullion profiles and locations.
3. Wiring Diagrams: For power, signal, and control wiring for motorized adjustable louvers.

C. Samples for Verification: For each type of metal finish required.

1.6 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

1.7 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Welding: Qualify procedures and personnel according to the following:

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1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

D. UL and NEMA Compliance: Provide motors and related components for motor-operated louvers that are listed and labeled by UL and comply with applicable NEMA standards.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B 26/B 26M, Alloy 319.

D. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use tamper-resistant screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For fastening stainless steel, use 300 series stainless-steel fasteners.
4. For color-finished louvers, use fasteners with heads that match color of louvers.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

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1. Frame Type: Channel unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.

1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
2. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
3. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
4. Exterior Corners: Prefabricated corner units with mitered [blades with concealed close-fitting splices and with fully recessed mullions at corners.

F. Join frame members to each other with fillet [welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.3 ADJUSTABLE, EXTRUDED-ALUMINUM LOUVERS

A. Louver Construction and Operation: Provide adjustable louvers with extruded-aluminum frames and blades not less than 0.080-inch (2.03-mm) nominal thickness, and with operating mechanisms to suit louver sizes.
1. Motor operation with 2-position, spring-return application (with power on, motor opens louver; with power off, spring closes louver); 110-V, 60-Hz motor and limit switch; equipped with frame-mounted switch.

2. Louver Depth: 4 inches (100 mm), overall.
3. Louver Performance Ratings:

a. Free Area: Not less than 6.0 sq. ft. (0.56 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
b. Point of Beginning Water Penetration: Not less than 750 fpm (3.8 m/s)] [800 fpm (4.1 m/s.
c. Air Performance: Not more than 0.10-inch wg (25-Pa)] static pressure drop at 750-fpm (3.8-m/s)] free-area exhaust velocity.
d. Air Leakage: Not more than [1.5 cfm/sq. ft. (7.6 L/s per sq. m)] <Insert air-leakage rating> of louver gross area at a differential static pressure of 0.15-inch wg (37 Pa) with adjustable louver blades closed.

4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

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B. Single-Blade, Adjustable Louver :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Air Balance Inc.; a Mestek company.
   b. Air Flow Company, Inc.
   c. Airolite Company, LLC (The).
   d. All-Lite Architectural Products.
   e. American Warming and Ventilating, Inc.; a Mestek company.
   f. Arrow United Industries; a division of Mestek, Inc.
   g. Carnes Company, Inc.
   h. Cesco Products; a division of Mestek, Inc.
   i. Construction Specialties, Inc.
   j. Dowco Products Group; Safe-Air of Illinois, Inc.
   k. Greenheck Fan Corporation.
   l. Industrial Louvers, Inc.
   m. Louvers & Dampers, Inc.; a division of Mestek, Inc.
   n. Metal Form Manufacturing Inc.
   o. NCA Manufacturing, Inc.
   p. Reliable Products, Inc.
   q. Ruskin Company; Tomkins PLC.
   r. United Enertech Corp.
   s. Vent Products Company, Inc.
   t. or approved equal.

2. Louver Depth: 4 inches (100 mm) .
3. Blade Type: Plain.
4. Accessories: Equip louvers as follows:

   a. Vinyl blade-edge gaskets for each louver blade.

5. Louver Performance Ratings:

   a. Free Area: Not less than 6.5 sq. ft. (0.60 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
   b. Point of Beginning Water Penetration: Not less than 500 fpm (2.5 m/s) .
   c. Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 500-fpm (2.5-m/s) free-area exhaust velocity.
   d. Air Leakage: Not more than 3.5 cfm/sq. ft. (17.8 L/s per sq. m) of louver gross area at a differential static pressure of 0.15-inch wg (37 Pa) with adjustable louver blades closed.

6. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

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2.5 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. High-Performance Organic Finish: 2-coat fluoropolymer finish complying with AAMA 260] and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: Match DIA Project Manager's sample.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect unpainted galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying

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a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Test operation of adjustable louvers and adjust as needed to produce fully functioning units that comply with requirements.

B. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by DIA Project Manager, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

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 089000

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SECTION 092216 - NON-STRUCTURAL METAL FRAMING

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. Non-load-bearing steel framing systems for interior gypsum board assemblies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data substantiating that materials comply with requirements.

1.4 INFORMATION SUBMITTALS

A. Evaluation Reports: For firestop tracks, from ICC-ES.

1.5 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".

1.6 QUALITY ASSURANCE

A. Single-Source Responsibility for Steel Framing: Obtain steel framing members for gypsum board assemblies from a single manufacturer, whenever possible, unless otherwise indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

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B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Neatly stack materials to prevent damage.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized, unless otherwise indicated.

B. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.

1. Steel Studs and Runners:

   a. Minimum Base-Metal Thickness: 0.027 inch (0.68 mm).
   b. Depth: As indicated on Drawings.

2. Dimpled Steel Studs and Runners:

   a. Minimum Base-Metal Thickness: 0.025 inch (0.64 mm).
   b. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches (305 mm) of the top of studs to provide lateral bracing.
2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- (51-mm-) deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.

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3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
      2) MBA Building Supplies; **FlatSteel Deflection Track**] [**Slotted Deflecto Track**].
      3) Steel Network Inc. (The); [**VertiClip SLD**] [**VertiTrack VTD**] Series.
      4) Superior Metal Trim; Superior Flex Track System (SFT).
      5) Telling Industries; [**Vertical Slip Track**] [**Vertical Slip Track II**].
      6) or approved equal.

D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

   1. Minimum Base-Metal Thickness: 0.027 inch (0.68 mm).

E. Cold-Rolled Channel Bridging: Steel, 0.053-inch (1.34-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.

   1. Depth: **As indicated on Drawings**.
   2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.
      a.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

   1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide **one of** the following:

   1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
   2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

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PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
   1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, furnishings, or similar construction. Comply with details indicated and with recommendations of gypsum board manufacturer or, if none available, with the most current edition of United States Gypsum Co. "Gypsum Construction Handbook."

C. Install bracing at terminations in assemblies.

D. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement. Comply with details shown on Drawings.

E. Install deflection track top runner to attain lateral support and avoid axial loading.

F. Install deflection and firestop track top runner at fire-resistance-rated assemblies where indicated.

G. Attach jamb studs at openings to tracks using manufacturer's standard stud clip.

H. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.3 INSTALLING FRAMED ASSEMBLIES

A. Where studs are installed directly against dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs so flanges within framing system point in same direction.

   1. Space studs as follows:

      a. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.

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C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.
    a.

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 applicable unit price item, work order or lump sum bid item.

END OF SECTION 092216

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SECTION 092900 - GYPSUM BOARD

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. Interior gypsum board.

B. Related Requirements:
1. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data substantiating that materials comply with requirements.

B. Shop Drawings showing locations, details, and installation of control and expansion joints including plans, elevations, sections, details of components, and attachments to other units of Work.

C. Submit shop drawing showing locations, layout and details of all metal trim.

1.4 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility for Panel Products: Obtain each type of gypsum board and other panel products from a single manufacturer.

B. Single-Source Responsibility for Finishing Materials: Obtain finishing materials from either the same manufacturer that supplies gypsum board and other panel products or

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from a manufacturer acceptable to gypsum board manufacturer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are fully enclosed and conditioned on a 24-hour basis.

C. Required Room Temperatures for Gypsum Panel Work:

1. For nonadhesive attachment of gypsum board to framing, maintain not less than 40 degrees F (4 degrees C).
2. Do not exceed 95 degrees F (35 degrees C) when using temporary heat sources.

D. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

E. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

F. Protect all installed panels from moisture damage. Replace all panels that become wet or damaged.

PART 2 - PRODUCTS

2.1 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

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2.2 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Gypsum.
2. CertainTeed Corp.
3. Georgia-Pacific Gypsum LLC.
4. Lafarge North America Inc.
5. National Gypsum Company.
6. PABCO Gypsum.
7. Temple-Inland.
8. USG Corporation.
9. or approved equal.

B. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch (15.9 mm).
2. Long Edges: Tapered.

2.3 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
2. Shapes:

    a. Cornerbead.
    b. Bullnose bead.
    c. LC-Bead: J-shaped; exposed long flange receives joint compound.
    d. L-Bead: L-shaped; exposed long flange receives joint compound.
    e. U-Bead: U-bead with face and back flanges; face flange formed to be left without application of joint compound. Use where indicated.
    f. Expansion (control) joint: One-piece control joint formed with V-shaped slot and removable strip covering slot opening.
    g. As indicated or required to achieve design intent.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Fry Reglet Corp.
    b. Gordon, Inc.
    c. Pittcon Industries.
    d. MM Systems, Inc.
    e. or approved equal.

2. Aluminum: Alloy and temper with not less than the strength and durability

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properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.

3. Finish:

   a. Primed Finish: Manufacturer's standard corrosion-resistant primer compatible with joint compound and finish materials specified.
   b. Color: Match color as provided by DIA Project Manager.

2.4 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

   1. Interior Gypsum Board: Paper.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

   1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

      a. Use setting-type compound for installing paper-faced metal trim accessories.

   3. Fill Coat: For second coat, use setting-type, sandable topping compound.
   4. Finish Coat: For third coat, use setting-type, sandable topping compound.
   5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

2.5 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

   1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

C. Separation Between Steel Framing and Exterior Walls:

   1. Asphalt-Saturated Organic Felt: ASTM D226, Type I (No. 15 asphalt felt), nonperforated.
   2. Foam Gaskets: Closed-cell vinyl foam adhesive-backed strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit metal stud size indicated.

D. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

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PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to which gypsum board assemblies attach or abut, installed hollow metal frames, cast-in-anchors, and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of assemblies specified in this Section.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected, and required environmental conditions have been achieved.

3.2 PREPARATION

A. Ceiling Anchorages: Coordinate installation of ceiling suspension systems with installation of overhead structural assemblies to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers that will develop their full strength and at spacing required to support ceilings.

3.3 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq.

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ft. (0.7 sq. m) in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases that are braced internally.

1. Except where concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
2. Fit gypsum panels accurately around ducts, pipes, and conduits.
3. Where partitions intersect open concrete coffers, concrete joists, and other structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by coffers, joists, and other structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

J. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's recommendations, applicable code requirements.

1. Space screws a maximum of 12 inches (304.8 mm) o.c. for vertical applications.

K. Spot grout hollow metal door frames for solid-core wood doors, hollow metal doors, and doors over 32 inches (813 mm) wide. Apply spot grout at each jamb anchor clip and immediately insert gypsum panels into frames.

3.4 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
1. Type X: As indicated on Drawings.

B. Single-Layer Application:
1. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
3.

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C.

3.5 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control and Expansion Joints: Install control and expansion joints at locations indicated on Drawings, and in full accordance with ASTM C 840, and in specific locations approved by DIA Project Manager for visual effect.

1. Submit drawing showing locations and details of all control joints and expansion joints.
2. If control joints are not fully indicated on Drawings, provide control joints and expansion joints in compliance with ASTM C 840, and indicate on shop drawing.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.
2. Bullnose Bead: Use at outside corners.
3. LC-Bead: Use at exposed panel edges.
4. L-Bead: Use where indicated.
5. U-Bead: Use at exposed panel edges.
6. Curved-Edge Cornerbead: Use at curved openings.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

    a. Primer and its application to surfaces are specified in other Section 099123 "Interior Painting." Level 5 is suitable for surfaces receiving gloss and semigloss enamels and other surfaces subject to severe lighting. It is considered a high-quality gypsum board finish.

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2. Level 5: Where indicated on Drawings.

   a. Primer and its application to surfaces are specified in other Section 099123 "Interior Painting."
   b.

3.7 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

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 applicable unit price item, work order or lump sum bid item.

END OF SECTION 092900

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SECTION 098433 - SOUND-ABSORBING WALL UNITS

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 shop-fabricated, fabric-wrapped panel units tested for acoustical performance, including:

1. Sound-absorbing wall panels.
2. Sound-diffusing wall panels.
3. Sound-reflecting wall panels.

B. Related Sections:

1. Section 097200 "Wall Coverings" for adhesively applied textile wall coverings[**and for coordinating requirements for fabric**].
2. Section 097713 "Stretched-Fabric Wall Systems" for site-upholstered systems for walls[**and for coordinating requirements for fabric**].
3. Section 097723 "Fabric-Wrapped Panels" for fabric-wrapped wall panels that are not required to be tested for acoustical performance[**and for coordinating requirements for fabric**].

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

B. SAA: Sound Absorption Average.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of[**fabric facing,**] panel edge, core material, and mounting indicated.

1. Include data substantiating that materials comply with requirements.

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B. Shop Drawings: For sound-absorbing wall units. Include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge and core materials.

1. Include elevations showing panel sizes and direction of fabric weave and pattern matching.

C. Samples for Initial Selection: For each type of fabric facing from sound-absorbing wall unit manufacturer's full range.

D. Samples for Verification: For the following products, prepared on Samples of size indicated below:

1. Fabric: Full-width by approximately [36-inch- (900-mm-)] <**Insert dimension**> long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
2. Panel Edge: 12-inch- (300-mm-) long Sample(s) showing each edge profile, corner, and finish.
3. Core Material: 12-inch- (300-mm-) square Sample at corner.
4. Mounting Devices: Full-size Samples.
5. Assembled Panels: Approximately 36 by 36 inches (900 by 900 mm), including joints and mounting methods.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets, switches, and thermostats.
2. Items penetrating or covered by sound-absorbing wall units including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Alarms.
e. Sprinklers.
f. Access panels.
g. <**Insert item**>.

3. Show operation of hinged and sliding components covered by or adjacent to sound-absorbing wall units.

B. Product Certificates: For each type of sound-absorbing wall unit, from manufacturer.

C. Warranty: Sample of special warranty.

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1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sound-absorbing wall units to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal recommendations.

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".

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, provide length equal to [**10**] <**Insert number**> percent of amount installed, but no fewer than [10 yards (9 m)] <**Insert quantity**>.
2. Mounting Devices: Full-size units equal to [**5**] <**Insert number**> percent of amount installed, but no fewer than [**five**] <**Insert number**> devices, including unopened adhesives.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain sound-absorbing wall units from single source from single manufacturer.

B. Fire-Test-Response Characteristics: Provide sound-absorbing wall units meeting the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.

   a. Flame-Spread Index: [**25**] <**Insert value**> or less.
   b. Smoke-Developed Index: [**450**] <**Insert value**> or less.

2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to [**NFPA 265**] [**NFPA 286**].

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials, fabrication, and installation.

1. Build mockup of typical wall area[**as shown on Drawings**] [**as directed by DEN Project Manager**] <**Insert requirement**>.[**Include intersection of wall and ceiling, corners, and perimeters.**]
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless DEN Project Manager specifically approves such deviations in writing.

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D. Preinstallation Conference: Conduct conference at [**Project site**] <[**location and time as determined by DEN Project Manager**] **Insert location**>.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and sound-absorbing wall unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not install sound-absorbing wall units until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install sound-absorbing wall units until [**a permanent level of lighting**] [**a lighting level of not less than** 50 fc (538 lux)] <**Insert requirement**> is provided on surfaces to receive the units.

C. Field Measurements: Verify locations of sound-absorbing wall units and actual dimensions of openings and penetrations by field measurements before fabrication.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sound-absorbing wall units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to the following:

    a. Acoustical performance.
    b. Fabric sagging, distorting, or releasing from panel edge.
    c. Warping of core.

2. Warranty Period: Minimum [**two (2)**] <**Insert number**> years from date of Substantial Completion.

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 this Section.

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PART 2 - PRODUCTS

2.1 SOUND-ABSORBING WALL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Acoustical Panel Systems (APS, Inc.).
2. Acoustical Solutions, Inc.
3. Armstrong World Industries.
4. AVL Systems, Inc.
5. Benton Brothers Solutions, Inc.
6. Conwed Designscape; an Owens Corning company.
7. Decoustics Limited; a CertainTeed Ceilings company.
8. Essi Acoustical Products.
9. Golterman & Sabo.
10. Kinetics Noise Control, Inc.
11. Lamvin, Inc.
12. MBI Products Company, Inc.
13. Panel Solutions, Inc.
14. Perdue Acoustics.
15. Pinta Acoustic, Inc.
16. Proudfoot Company, Inc. (The).
17. Sound Concepts Canada, Inc.
18. Sound Management Group LLC.
19. Tectum Inc.
20. Wall Technology, Inc.; an Owens Corning company.
21. Working Walls, Inc.
22. <**Insert manufacturer's name**>.
23. or approved equal.

B. General Requirements for Sound-Absorbing Wall Units: Units 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. Sound-Absorbing Wall Panel <**Insert drawing designation**>: Manufacturer's standard panel construction consisting of facing material [**laminated to front face, edges, and back edge border of core**] [**stretched over front face of edge-framed core and bonded or attached to edges and back of frame**] <**Insert description**>.
1. Mounting: Edge mounted with splines secured to substrate.

    a. Finish Color at Exposed Edges: [**White**] [**Black**] [**Match color of facing material**] [**Match DEN Project Manager's sample**] [**As selected by DEN Project Manager from manufacturer's full range**] <**Insert requirement**>.

2. Mounting: Back mounted with manufacturer's standard [**adhesive**] [**adhesive tape strips**] [**hook-and-loop strips**] [**impaling clips**] [**magnetic devices**] [**metal clips or bar hangers**], secured to substrate.

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3. Core: [**Manufacturer's standard**] [**glass-fiber board**] [**mineral-fiber board**] [**or**] [**cementitious-fiber board**] <**Insert requirement**>.[**Provide wood or plywood nailing strips in core where indicated.**]

    a. Core-Face Layer: Manufacturer's standard [**tackable, impact-resistant, high-density board**] [**impact-resistant, acoustically transparent, copolymer sheet**] <**Insert requirement**>.

4. Edge Construction: Manufacturer's standard [**chemically hardened core with no frame**] [**extruded-aluminum or zinc-coated, rolled-steel frame**] [**extruded PVC frame**] [**wood frame, rabbeted, and splined with glued joints and machined corners**] <**Insert requirement**>.
5. Edge Profile: [**Long edges kerfed and rabbeted to receive splines**] [**Chamfered (beveled)**] [**Eased (small radius)**] [**Mitered (beveled to a point)**] [**Radiused (bullnosed)**] [**Square**] [**Custom profile as indicated on Drawings**] <**Insert profile**>.
6. Corner Detail in Elevation: [**Square**] [**Round, radius as indicated on Drawings**] [**Custom as indicated on Drawings**] <**Insert description**> with continuous edge profile indicated.
7. Reveals between Panels: [**Recessed**] [**Flush**] [**Projecting**] reveals [**as selected by DEN Project Manager from manufacturer's full range**] [**as indicated on Drawings**] <**Insert requirement**>.
8. Facing Material: [**Owner-furnished material**] [**As indicated on Drawings**] <**Insert drawing designation**>.
9. Acoustical Performance: Sound absorption [**NRC**] [**or**] [**SAA**] of [**0.50 to 0.90**] [**0.60 to 0.70**] [**0.65 to 0.75**] [**not less than 0.65**] <**Insert range or single value**> according to ASTM C 423 for [**Type A**] <**Insert Type**> mounting according to ASTM E 795.
10. Nominal [**Core**] [**Overall Panel**] Thickness: [3/4 inch (19 mm)] [1 inch (25 mm)] [1-1/2 inches (38 mm)] [2 inches (51 mm)] [**As indicated on Drawings**] <**Insert dimension**>.
11. Panel Width: [24 inches (610 mm)] [30 inches (762 mm)] [48 inches (1220 mm)] [**As indicated on Drawings**] <**Insert dimension**>.
12. Panel Height: [72 inches (1829 mm)] [96 inches (2438 mm)] [108 inches (2743 mm)] [120 inches (3048 mm)] [**As indicated on Drawings**] <**Insert dimension**>.

D. Sound-[**Diffusing**] [**Reflecting**] Wall Panel <**Insert drawing designation**>: Manufacturer's standard panel construction consisting of facing material [**laminated to front face, edges, and back edge border of core**] <**Insert description**>.
1. Panel Shape: [**Barrel**] [**Pyramidal**] [**Radially curved flat panel**] [**As indicated on Drawings**] <**Insert shape**>.
2. Mounting: Back mounted with manufacturer's standard [**adhesive**] [**adhesive tape strips**] [**hook-and-loop strips**] [**impaling clips**] [**magnetic devices**] [**metal clips or bar hangers**], secured to substrate.
3. Core: [**Manufacturer's standard**] [**glass-fiber board with a reflective component**] [**mineral-fiber board with a reflective component**] [**cementitious-fiber board with a reflective component**] [**fire-retardant formed plastic**] [**medium-density fiberboard**] [**or**] [**particleboard**] <**Insert requirement**>, prepared for required acoustical performance.

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4. Edge Construction: Manufacturer's standard [**chemically hardened core with no frame**] <**Insert requirement**>.
5. Reveals between Panels: [**Recessed**] [**Flush**] [**Projecting**] reveals [**as selected by DEN Project Manager from manufacturer's full range**] [**as indicated on Drawings**] <**Insert requirement**>.
6. Facing Material: [**Owner-furnished material**] [**As indicated on Drawings**] <**Insert drawing designation**>.
7. Acoustical Performance: Sound absorption [**NRC**] [**or**] [**SAA**] of [**0.05 to 0.10**] [**0.15 to 0.25**] [**0.30 to 0.40**] [**not more than 0.35**] <**Insert range or single value**> according to ASTM C 423 for [**Type A**] <**Insert Type**> mounting according to ASTM E 795.
8. Panel Width: [24 inches (610 mm)] [30 inches (762 mm)] [48 inches (1220 mm)] [**As indicated on Drawings**] <**Insert dimension**>.
9. Panel Height: [72 inches (1829 mm)] [96 inches (2438 mm)] [108 inches (2743 mm)] [120 inches (3048 mm)] [**As indicated on Drawings**] <**Insert dimension**>.

2.2 MATERIALS

A. General:

1. Minimum Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert number**> percent by weight.
2. Regional Materials: Sound-absorbing wall units shall be manufactured within 500 miles (800 km) of Project site.
3. Certified Wood: Fabricate products with wood-based components produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Core Materials:[**Manufacturer's standard.**]

1. Glass-Fiber Board: ASTM C 612, Type standard with manufacturer; nominal density of [6 to 7 lb/cu. ft. (96 to 112 kg/cu. m)] <**Insert value**>, unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. Mineral-Fiber Board: Maximum flame-spread and smoke-developed indexes of 25 and 10, respectively; minimum density of [13 lb/cu. ft. (208 kg/cu. m)] [20 lb/cu. ft. (320 kg/cu. m)], and with perforated surface.
3. Cementitious-Fiber Board: Density of not less than [20 lb/cu. ft. (320 kg/cu. m)] <**Insert value**>.
4. Fire-Retardant Formed Plastic: Manufacturer's standard formed plastic with flame-spread index of 25 or less and smoke-developed index of 25 or less according to ASTM E 84.
5. Medium-Density Fiberboard: Panels complying with ANSI A208.2, Grade M-2.

    a. Made with binder containing no urea formaldehyde.
    b. Panels shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the

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Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

c. Fire-retardant panels made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less per ASTM E 84.

6. Particleboard: Panels complying with ANSI A208.1, Grade M-2.

   a. Made with binder containing no urea formaldehyde.
   b. Panels 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. Fire-retardant panels made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less per ASTM E 84.

7. Tackable, Impact-Resistant, High-Density Board for Face Layer: 1/8-inch- (3.2-mm-) thick layer of compressed molded glass-fiber board with a nominal density of 16 to 18 lb/cu. ft. (256 to 288 kg/cu. m) laminated to face of core.
8. Impact-Resistant, Acoustically Transparent, Copolymer Sheet for Face Layer: 1/16- to 1/8-inch- (1.6- to 3.2-mm-) thick layer of perforated, noncombustible, copolymer sheet laminated to face of core.
9. Wood and Plywood: Manufacturer's standard plywood or clear, vertical grain, straight, kiln-dried hardwood.

   a. Plywood 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. Fire-retardant treated by pressure process with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

      1) Treated material shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity.
      2) Kiln-dry material after treatment to 7 to 13 percent or less for lumber and 15 percent or less for plywood.

C. Facing Material <**Insert drawing designation**>: Fabric from same dye lot; color and pattern [**as indicated by manufacturer's designations**] [**matching DEN Project Manager's samples**] [**as selected by DEN Project Manager from manufacturer's full range**] [**as indicated on Drawings**] <**Insert requirement**>.

1. Manufacturer: <**Insert manufacturer's name**>.

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2. Product Line/Pattern: <**Insert product name or designation**>.
3. Pattern Repeat: <**Insert requirement**>.
4. Style Number: <**Insert number**>.
5. Color: <**Insert name or number, or both**>.
6. Fiber Content: [**100**] <**Insert number**> percent [**woven polyester**] [**nonwoven polyester**] [**polyolefin**] [**acoustically transparent vinyl**] <**Insert fiber requirement**>.
7. Width: [54 inches (1371 mm)] [66 inches (1676 mm)] <**Insert dimension**>.
8. Source: <**Insert fabric-vendor's name**>.
9. Applied Treatments: [**Stain resistance**] <**Insert treatment**>.

D. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:

1. Splines: Manufacturer's standard concealed metal or plastic splines that engage the kerfed edges of the unit, with other moldings and trim for interior corners, exterior corners, and exposed edges, with factory-applied finish on exposed items.
2. Adhesives: As recommended by sound-absorbing wall unit manufacturer and with a VOC content of [**70**] <**Insert value**> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesives: As recommended by sound-absorbing wall unit manufacturer and that 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."
4. Adhesive Tape Strips: [**Manufacturer's standard** 1/16-inch- (1.6-mm-) **thick, double-sided foam tape**] <**Insert requirement**>.
5. Hook-and-Loop Strips: [**Manufacturer's standard**] <**Insert requirement**>.
6. Impaling Clips: [**Manufacturer's standard**] <**Insert requirement**>.
7. Magnetic Strip or Devices: [**Manufacturer's standard**] <**Insert requirement**>.
8. Metal Clips or Bar Hangers: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.

2.3 FABRICATION

A. General: Use manufacturer's standard construction except as otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

1. [**Glass-Fiber Board**] [**and**] [**Mineral-Fiber Board**] Cores: Chemically harden core edges and areas of core where mounting devices are attached.

B. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.

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C. Facing Material: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

1. Square Corners: Tailor corners.[**Heat seal vinyl fabric seams at corners.**]
2. Radius and Other Nonsquare Corners: Attach facing material so there are no seams or gathering of material.
3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.

D. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch (1.6 mm) for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, fabricated units, substrates, areas, and conditions, for compliance with requirements, installation tolerances, and other conditions affecting performance of sound-absorbing wall units.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sound-absorbing wall units in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with sound-absorbing wall unit manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

C. Align and level fabric pattern and grain among adjacent units.

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus [1/16 inch (1.6 mm)] <**Insert dimension**>.

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B. Variation of Panel Joints from Hairline: Not more than [1/16 inch (1.6 mm)] [1/32 inch (0.79 mm)] <**Insert dimension**> wide.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

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 098433

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SECTION 099123 - INTERIOR PAINTING

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 surface preparation and the application of paint systems on the following interior substrates:
   1. Concrete masonry units (CMU).
   2. Steel.
   3. Galvanized metal.
   4. Aluminum (not anodized or otherwise coated).
   5. Wood.
   6. Gypsum board.

1.3 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

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1. Include data substantiating that materials comply with requirements.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.
5. Provide a list of materials and applications for each coat of each Sample. Label each Sample for location and application.
6. Resubmit until required sheen, color, and texture are achieved.
7. Submit 3 samples on the following substrates for DIA Project Manager's review of color and texture only:
   a. Painted Wood: 8-inch- square Samples for each color and material on hardboard.
   b. Ferrous Metal: 3-inch- square Samples of flat metal and 6-inch- long Samples of solid metal for each color and finish.

D. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. DIA Project Manager will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.

   a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).

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b. Other Items: DIA Project Manager will designate items or areas required.

2. Final approval of color selections will be based on mockups.

a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by DIA Project Manager at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless DIA Project Manager specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label and the following information:

1. Product name or title of material.
2. Product description (generic classification or binder type).
3. Manufacturer's stock number and date of manufacture.
4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 90 deg F (10 and 33 deg C).

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

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1.9 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner, and store in location as determined by DIA Project Manager.

1. Quantity: Furnish Owner with an additional 5 percent, but not less than 1 gal., as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. Benjamin Moore & Co.
2. ICI Dulux Paints.
3. Kelly-Moore Paints.
4. M.A.B. Paints.
5. PPG Architectural Finishes, Inc.
6. Sherwin-Williams Company (The).
7. Sico, Inc.
8. or approved equal.

B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles for the paint category indicated, or equal approved by DIA Project Manager.

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. Colors: Match DIA Project Manager's samples.

1. 10 20 30 <Insert number> percent of surface area will be painted with deep tones.

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2.3 BLOCK FILLERS

A. Block Filler, Latex, Interior/Exterior: MPI #4.

1. Benjamin Moore; Moorcraft Super Craft Latex Block Filler No. 285: Applied at a dry film thickness of not less than 8.1 mils.
2. Benjamin Moore; Moore's IMC Latex Block Filler No. M88: Applied at a dry film thickness of not less than 8.1 mils.
3. ICI Dulux Paints; Bloxfil 4000-1000 Interior/Exterior Heavy Duty Acrylic Block Filler: Applied at a dry film thickness of not less than 7.0 to 14.5 mils.
4. Kelly-Moore; 521 Fill and Prime Acrylic Block Filler: Applied at a dry film thickness of not less than 10.0 mils.
5. M. A. B. Paint; Block Kote No. 1000 Acrylic Latex Block Filler 064-145: Applied at a dry film thickness of not less than 12.0 mils.
6. Pittsburgh Paints; 6-7 SpeedHide Interior/Exterior Masonry Latex Block Filler: Applied at a dry film thickness of not less than 6.0 to 12.5 mils.
7. Sherwin-Williams; PrepRite Interior/Exterior Block Filler B25W25: Applied at a dry film thickness of not less than 8.0 mils.
8. or approved equal.

2.4 PRIMERS/SEALERS

A. Primer Sealer, Latex, Interior: MPI #50.

1. Benjamin Moore; Moorcraft Super Spec Latex Enamel Undercoater & Primer Sealer No. 253: Applied at a dry film thickness of not less than 1.2 mils.
2. ICI Dulux Paints; 1000-1200 Dulux Ultra Basecoat Interior Latex Wall Primer: Applied at a dry film thickness of not less than 1.2 mils.
3. ICI Dulux Paints; 1030-1200 Ultra-Hide PVA Interior Primer Sealer General Purpose Wall Primer: Applied at a dry film thickness of not less than 1.9 mils.
4. Kelly-Moore; 971 Acry-Prime Interior Latex Primer/Sealer: Applied at a dry film thickness of not less than 1.6 mils.
5. M. A. B. Paint; Fresh Kote Vinyl Primer 037-100: Applied at a dry film thickness of not less than 1.5 mils.
6. Pittsburgh Paints; 6-2 SpeedHide Interior Quick-Drying Latex Sealer: Applied at a dry film thickness of not less than 1.0 mil.
7. Sherwin-Williams; PrepRite 200 Latex Wall Primer B28W200 Series: Applied at a dry film thickness of not less than 1.6 mils.
8. or approved equal.

B. Primer Sealer, Interior, Institutional Low Odor/VOC: MPI #149.

C. Primer, Latex, for Interior Wood: MPI #39.

1. Benjamin Moore; Moorcraft Super Spec Alkyd Enamel Underbody and Primer Sealer No. 245: Applied at a dry film thickness of not less than 1.5 mils.
2. ICI Dulux Paints; 3210-1200 Ultra-Hide Aquacrylic GRIPPER Stain Killer Primer Sealer: Applied at a dry film thickness of not less than 1.8 mils.
3. Kelly-Moore; 975 Acry Plex Interior Latex Enamel Undercoat: Applied at a dry film thickness of not less than 1.6 mils.

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4. M. A. B. Paint; Rich Lux Latex Undercoat 037-154: Applied at a dry film thickness of not less than 1.5 mils.
5. Pittsburgh Paints; 6-855 SpeedHide Latex Enamel Undercoater: Applied at a dry film thickness of not less than 1.0 mil.
6. Sherwin-Williams; PrepRite Wall and Wood Primer B49W200 Series: Applied at a dry film thickness of not less than 1.6 mils.
7. Sherwin-Williams; PrepRite Classic Interior Primer B28W101 Series: Applied at a dry film thickness of not less than 1.6 mils.
8. or approved equal.

2.5 METAL PRIMERS

A. Primer, Rust-Inhibitive, Water Based: MPI #107.

1. Benjamin Moore; Moore's IMC Alkyd Metal Primer No. M06: Applied at a dry film thickness of not less than 2.0 mils.
2. ICI Dulux Paints; 4130-6130 Devshield Rust Penetrating Metal Primer: Applied at a dry film thickness of not less than 2.2 mils.
3. ICI Dulux Paints; 4160-6130 Devguard Multi-Purpose Tank & Structural Primer: Applied at a dry film thickness of not less than 2.0 mils.
4. Kelly-Moore; 1711 Kel-Guard Alkyd White Rust Inhibitive Primer: Applied at a dry film thickness of not less than 2.0 mils.
5. M. A. B. Paint; Rust-O-Lastic Anti-Corrosive Primer 073-132: Applied at a dry film thickness of not less than 2.0 mils.
6. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel: Applied at a dry film thickness of not less than 1.5 mils.
7. Sherwin-Williams; Kem Kromik Universal Metal Primer B50NZ6/B50WZ1: Applied at a dry film thickness of not less than 3.0 mils.
8. or approved equal.

B. Primer, Alkyd, Anti-Corrosive, for Metal: MPI #79.

C. Primer, Alkyd, Quick Dry, for Metal: MPI #76.

D. Primer, Galvanized, Water Based: MPI #134.

1. Benjamin Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils.
2. ICI Dulux Paints; 4160-6130 Devguard Multi-Purpose Tank & Structural Primer: Ap-plied at a dry film thickness of not less than 2.0 mils.
3. Kelly-Moore; 1722 Kel-Guard Acrylic Galvanized Iron Primer: Applied at a dry film thickness of not less than 1.8 mils.
4. M. A. B. Paint; Rust-O-Lastic Hydro-Prime II Acrylic (DTM) Maintenance Primer 073-189: Applied at a dry film thickness of not less than 2.0 mils.
5. Pittsburgh Paints; 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM In-dustrial Enamel: Applied at a dry film thickness of not less than 3.0 mils.
6. Sherwin-Williams; primer not required over this substrate.
7. Sherwin-Williams; Galvite HS B50WZ30: Applied at a dry film thickness of not less than 3.0 mils.
8. or approved equal.

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E. Primer, Quick Dry, for Aluminum: MPI #95.

2.6 WATER-BASED PAINTS

A. Latex, Interior, Flat, (Gloss Level 1): MPI #53.

1. Benjamin Moore; Moorecraft Super Spec Latex Flat No. 275: Applied at a dry film thickness of not less than 1.2 mils.
2. ICI Dulux Paints; 1200-XXXX Dulux Professional Velvet Matte Interior Flat Latex Wall & Trim Finish: Applied at a dry film thickness of not less than 1.4 mils.
3. Kelly-Moore; 450 Pro-Wall Interior Flat Latex Wall Paint: Applied at a dry film thick-ness of not less than 1.8 mils.
4. M. A. B. Paint; Fresh Kote Latex Flat 402 Line: Applied at a dry film thickness of not less than 1.5 mils.
5. Pittsburgh Paints; 6-70 Line SpeedHide Interior Wall Flat-Latex Paint: Applied at a dry film thickness of not less than 1.0 mil.
6. Sherwin-Williams; ProMar 200 Interior Latex Flat Wall Paint B30W200 Series: Applied at a dry film thickness of not less than 1.4 mils.
7. or approved equal.

B. Latex, Interior, Eggshell, (Gloss Level 2): MPI #44.

1. Benjamin Moore; Moorcraft Super Spec Latex Eggshell Enamel No. 274: Applied at a dry film thickness of not less than 1.3 mils.
2. ICI Dulux Paints; 1402-XXXX Dulux Professional Acrylic Eggshell Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.4 mils.
3. Kelly-Moore; 1610 Sat-N-Sheen Interior Latex Low Sheen Wall and Trim Finish: Ap-plied at a dry film thickness of not less than 1.6 mils.
4. Kelly-Moore; 1686 Dura-Poxy Eggshell Acrylic Enamel: Applied at a dry film thick-ness of not less than 1.6 mils.
5. M. A. B. Paint; Fresh Kote Latex Satin Eggshell Enamel 405 Line: Applied at a dry film thickness of not less than 1.5 mils.
6. Pittsburgh Paints; 6-400 Series SpeedHide Eggshell Acrylic Latex Enamel: Applied at a dry film thickness of not less than 1.25 mils.
7. Sherwin-Williams; ProMar 200 Interior Latex Egg-Shell Enamel B20W200 Series: Applied at a dry film thickness of not less than 1.6 mils.
8. or approved equal.

C. Latex, Interior, (Gloss Level 3): MPI #52.

D. Latex, Interior, (Gloss Level 4): MPI #43.

E. Latex, Interior, Semi-Gloss, (Gloss Level 5): MPI #54.

1. Benjamin Moore; Moorcraft Super Spec Latex Semi-Gloss Enamel No. 276: Applied at a dry film thickness of not less than 1.2 mils.
2. ICI Dulux Paints; 1406-XXXX Dulux Professional Acrylic Semi-Gloss Interior Wall & Trim Enamel: Applied at a dry film thickness of not less than 1.5 mils.
3. Kelly-Moore; 1649 Acrylic-Latex Semi-Gloss Enamel: Applied at a dry film thickness of not less than 1.7 mils.

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4. Kelly-Moore; 1685 Dura-Poxy Semi-Gloss Acrylic Enamel: Applied at a dry film thick-ness of not less than 1.5 mils.
5. M. A. B. Paint; Fresh Kote Latex Semi-Gloss 410 Line: Applied at a dry film thickness of not less than 1.5 mils.
6. Pittsburgh Paints; 6-500 Series SpeedHide Interior Semi-Gloss Latex: Applied at a dry film thickness of not less than 1.0 mil.
7. Sherwin-Williams; ProMar 200 Interior Latex Semi-Gloss Enamel B31W200 Series: Applied at a dry film thickness of not less than 1.3 mils.
8. or approved equal.

F. Latex, Interior, Gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees): MPI #114.

1. Benjamin Moore; Moore's IMC Acrylic Gloss Enamel No. M28: Applied at a dry film thickness of not less than 2.0 mils.
2. ICI Dulux Paints; 3028-XXXX Dulux Interior/Exterior Acrylic Gloss Finish: Applied at a dry film thickness of not less than 1.6 mils.
3. Kelly-Moore; 1680 Dura-Poxy Gloss Acrylic Enamel: Applied at a dry film thickness of not less than 1.6 mils.
4. M. A. B. Paint; Rich Lux Architectural High Gloss Latex Enamel 022-127 Line: Applied at a dry film thickness of not less than 1.5 mils.
5. Pittsburgh Paints; 6-8534 SpeedHide Interior Latex 100 Percent Acrylic Gloss Enamels: Applied at a dry film thickness of not less than 1.0 mil.
6. Pittsburgh Paints; 90-374 Pitt-Tech One Pack Interior/Exterior High Performance Waterborne High Gloss DTM Industrial Enamel (recommended for ferrous and zinc-coated metal): Applied at a dry film thickness of not less than 3.0 mils.
7. or approved equal.

G. Latex, Interior, Institutional Low Odor/VOC, Flat (Gloss Level 1): MPI #143.

H. Latex, Interior, Institutional Low Odor/VOC, (Gloss Level 2): MPI #144.

I. Latex, Interior, Institutional Low Odor/VOC, (Gloss Level 3): MPI #145.

J. Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (Gloss Level 5): MPI #147.

K. Latex, Interior, High Performance Architectural, (Gloss Level 2): MPI #138.

L. Latex, Interior, High Performance Architectural, (Gloss Level 3): MPI #139.

M. Latex, Interior, High Performance Architectural, (Gloss Level 4): MPI #140.

N. Latex, Interior, High Performance Architectural, Semi-Gloss (Gloss Level 5): MPI #141.

2.7 ALUMINUM PAINT

A. Aluminum Paint: MPI #1.

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PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Proceed with paint application only after unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
2. Start of painting will be construed as Contractor's acceptance of surfaces and conditions within a particular area.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Wood: 15 percent.
2. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:

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1. SSPC-SP 2, "Hand Tool Cleaning."

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

G. Aluminum Substrates: Remove loose surface oxidation.

H. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

I. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
2. Stir material before application to produce a mixture of uniform density. Stir as re-quired during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.

a. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
b. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
c. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

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4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
6. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
7. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
8. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
9. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and film thickness required are the same regardless of applica-tion method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
2. Omit primer over metal surfaces that have been shop primed and touchup painted.
3. If undercoats, stains, or other conditions show through final coat of paint, apply addi-tional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

C. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

D. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

E. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

F. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in occupied spaces:

a. Equipment, including panelboards.
b. Uninsulated metal piping.

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c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
h. Other items as directed by DIA Project Manager.

2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness. Samples of material delivered to Project will be taken, identified, sealed, and certified in the presence of Contractor.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing, and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.
3. If necessary, Contractor may be required to remove noncomplying paint from previously painted surfaces if, on repainting with specified paint, the two coatings are incompatible.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by DIA Project Manager, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

E. Provide "Wet Paint" signs, warning tape and any other measures required to protect newly painted finishes and prevent the public from encountering freshly painted surfaces.. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.

1. After work of other trades is complete, touch up and restore damaged or defaced

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painted surfaces. Comply with procedures specified in PDCA P1.

3.6 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. Latex System:

   a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
   b. Intermediate Coat: Latex, interior, matching topcoat.
   c. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
   d. Topcoat: Latex, interior, (Gloss Level 2), MPI #44.
   e. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.
   f. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
   g. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
   h. Topcoat: Latex, interior, gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.

2. Institutional Low-Odor/VOC Latex System:

3. Block Filler: Block filler, latex, interior/exterior, MPI #4.

4. For a Premium Grade system, "MPI Manual" requires intermediate coat; delete intermediate coat for a Custom Grade system.

5. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.

6. Retain one of four "Topcoat" subparagraphs below.

7. Topcoat: Latex, interior, institutional low odor/VOC, flat (Gloss Level 1), MPI #143.

8. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2), MPI #144.

9. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.

10. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (Gloss Level 5), MPI #147.

11. "High-Performance Architectural Latex System" Subparagraph below corresponds to MPI INT 4.2D. It is recommended for use in high-traffic and high-contact areas (e.g., public corridors in institutional buildings).

12. High-Performance Architectural Latex System:

13. Block Filler: Block filler, latex, interior/exterior, MPI #4.

14. For a Premium Grade system, "MPI Manual" requires intermediate coat; delete intermediate coat for a Custom Grade system.

15. Intermediate Coat: Latex, interior, high performance architectural, matching

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topcoat.

16. Retain one of four "Topcoat" subparagraphs below.

17. Topcoat: Latex, interior, high performance architectural, (Gloss Level 2), MPI #138.

18. Topcoat: Latex, interior, high performance architectural, (Gloss Level 3), MPI #139.

19. Topcoat: Latex, interior, high performance architectural, (Gloss Level 4), MPI #140.

20. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

21. "Water-Based Light Industrial Coating System" Subparagraph below corresponds to MPI INT 4.2K.

22. Water-Based Light Industrial Coating System:

23. Block Filler: Block filler, latex, interior/exterior, MPI #4.

24. For a Premium Grade system, "MPI Manual" requires intermediate coat; delete intermediate coat for a Custom Grade system.

25. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.

26. Retain one of three "Topcoat" subparagraphs below.

27. Topcoat: Light industrial coating, interior, water based (Gloss Level 3), MPI #151.

28. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5), MPI #153.

29. Topcoat: Light industrial coating, interior, water based, gloss (Gloss Level 6), MPI #154.

30. Alkyd System:

31. Block Filler: Block filler, latex, interior/exterior, MPI #4.

32. Retain "Sealer Coat" Subparagraph below for MPI INT 4.2N; delete for MPI INT 4.2C.

33. Sealer Coat: Primer sealer, latex, interior, MPI #50.

34. For a Premium Grade system, "MPI Manual" requires intermediate coat; delete intermediate coat for a Custom Grade system.

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35. Intermediate Coat: Alkyd, interior, matching topcoat.

36. Retain one of four "Topcoat" subparagraphs below.

37. Topcoat: Alkyd, interior, flat (Gloss Level 1), MPI #49.

38. Topcoat: Alkyd, interior, (Gloss Level 3), MPI #51.

39. Topcoat: Alkyd, interior, semi-gloss (Gloss Level 5), MPI #47.

40. Topcoat: Alkyd, interior, gloss (Gloss Level 6), MPI #48.

B. Steel Substrates:

1. Latex over Alkyd Primer System:

    a. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79
    b. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
    c. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79 or primer, alkyd, quick dry, for metal, MPI #76.
    d. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
    e. Topcoat: Latex, interior, (Gloss Level 2), MPI #44.
    f. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.
    g. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
    h. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
    i. Topcoat: Latex, interior, gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.

2. Institutional Low-Odor/VOC Latex System:

    a. Prime Coat: Primer, rust-inhibitive, water based MPI #107.
    b. Topcoat: Latex, interior, institutional low odor/VOC, flat (Gloss Level 1), MPI #143.
    c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2), MPI #144.
    d. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.
    e. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (Gloss Level 5), MPI #147.

3. High-Performance Architectural Latex System:

    a. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
    b. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
    c. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79 or primer, alkyd, quick dry, for metal, MPI #76.
    d. Topcoat: Latex, interior, high performance architectural, (Gloss Level 2), MPI #138.
    e. Topcoat: Latex, interior, high performance architectural, (Gloss Level 3), MPI #139.

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f. Topcoat: Latex, interior, high performance architectural, (Gloss Level 4), MPI #140.
g. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

4. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer, rust-inhibitive, water based MPI #107.
b. Topcoat: Light industrial coating, interior, water based (Gloss Level 3), MPI #151.
c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5), MPI #153.
d. Topcoat: Light industrial coating, interior, water based, gloss (Gloss Level 6), MPI #154.

5. Alkyd System:

a. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
b. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
c. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79 or primer, alkyd, quick dry, for metal, MPI #76.
d. Intermediate Coat: Alkyd, interior, matching topcoat.
e. Topcoat: Alkyd, interior, flat (Gloss Level 1), MPI #49.
f. Topcoat: Alkyd, interior, (Gloss Level 3), MPI #51.
g. Topcoat: Alkyd, interior, semi-gloss (Gloss Level 5), MPI #47.
h. Topcoat: Alkyd, interior, gloss (Gloss Level 6), MPI #48.

6. Quick-Drying Enamel System:

a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
b. Intermediate Coat: Alkyd, quick dry, matching topcoat.
c. Topcoat: Alkyd, quick dry, semi-gloss (Gloss Level 5), MPI #81.
d. Topcoat: Alkyd, quick dry, gloss (Gloss Level 7), MPI #96.
e.

7. Aluminum Paint System:

a. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79.
b. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
c. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79 or primer, alkyd, quick dry, for metal, MPI #76.
d. Topcoat: Aluminum paint, MPI #1.

C. Galvanized-Metal Substrates:

1. Latex over Waterborne Primer System:

a. Prime Coat: Primer, galvanized, water based, MPI #134.
b. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
c. Topcoat: Latex, interior, (Gloss Level 2), MPI #44.
d. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.

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e. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
f. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
g. Topcoat: Latex, interior, gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.

2. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Primer, galvanized, water based, MPI #134.
b. Topcoat: Latex, interior, institutional low odor/VOC, flat (Gloss Level 1), MPI #143.
c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2), MPI #144.
d. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.
e. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (Gloss Level 5), MPI #147.

3. High-Performance Architectural Latex System:

a. Prime Coat: Primer, galvanized, water based, MPI #134.
b. Topcoat: Latex, interior, high performance architectural, (Gloss Level 2), MPI #138.
c. Topcoat: Latex, interior, high performance architectural, (Gloss Level 3), MPI #139.
d. Topcoat: Latex, interior, high performance architectural, (Gloss Level 4), MPI #140.
e. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

4. Water-Based Light Industrial Coating Over Waterborne Primer System:

a. Prime Coat: Primer, galvanized, water based, MPI #134.
b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
c. Topcoat: Light industrial coating, interior, water based (Gloss Level 3), MPI #151.
d. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5), MPI #153.
e. Topcoat: Light industrial coating, interior, water based, gloss (Gloss Level 6), MPI #154.

5. Aluminum Paint System:

a. Prime Coat: Primer, galvanized metal, as recommended in writing by topcoat manufacturer for use on galvanized-metal substrates with topcoat indicated.
b. Topcoat: Aluminum paint, MPI #1.

D. Aluminum (Not Anodized or Otherwise Coated) Substrates:

1. Latex System:

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a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
b. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
c. Topcoat: Latex, interior, (Gloss Level 2), MPI #44.
d. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.
e. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
f. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
g. Topcoat: Latex, interior, gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.

2. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
b. Topcoat: Latex, interior, institutional low odor/VOC, flat (Gloss Level 1), MPI #143.
c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2), MPI #144.
d. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.
e. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (Gloss Level 5), MPI #147.

3. High-Performance Architectural Latex System:

a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
b. Topcoat: Latex, interior, high performance architectural, (Gloss Level 2), MPI #138.
c. Topcoat: Latex, interior, high performance architectural, (Gloss Level 3), MPI #139.
d. Topcoat: Latex, interior, high performance architectural, (Gloss Level 4), MPI #140.
e. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

4. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
b. Topcoat: Light industrial coating, interior, water based (Gloss Level 3), MPI #151.
c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5), MPI #153.
d. Topcoat: Light industrial coating, interior, water based, gloss (Gloss Level 6), MPI #154.

5. Alkyd System:

a. Prime Coat: Primer, vinyl wash, MPI #80.
b. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
c. Topcoat: Alkyd, interior, flat (Gloss Level 1), MPI #49.
d. Topcoat: Alkyd, interior, (Gloss Level 3), MPI #51.
e. Topcoat: Alkyd, interior, semi-gloss (Gloss Level 5), MPI #47.
f. Topcoat: Alkyd, interior, gloss (Gloss Level 6), MPI #48.

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6. Aluminum Paint System:

    a. Prime Coat: Primer, vinyl wash, MPI #80.
    b. Topcoat: Aluminum paint, MPI #1.

E. Wood Substrates: Including wood trim and touch up of existing interior wood substrates damaged by renovation work.

1. Latex System:

    a. Prime Coat: Primer, latex, for interior wood, MPI #39.
    b. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
    c. Topcoat: Latex, interior, (Gloss Level 2), MPI #44.
    d. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.
    e. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
    f. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
    g. Topcoat: Latex, interior, gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.

2. Latex over Alkyd Primer System:

    a. Prime Coat: Primer sealer, alkyd, interior, MPI #45.
    b. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
    c. Topcoat: Latex, interior, (Gloss Level 2), MPI #44.
    d. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.
    e. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
    f. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
    g. Topcoat: Latex, interior, gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.

3. Institutional Low-Odor/VOC Latex System:

    a. Prime Coat: Primer, latex, for interior wood, MPI #39.
    b. Topcoat: Latex, interior, institutional low odor/VOC, flat (Gloss Level 1), MPI #143.
    c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2), MPI #144.
    d. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.
    e. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (Gloss Level 5), MPI #147.

4. High-Performance Architectural Latex System:

    a. Prime Coat: Primer, latex, for interior wood, MPI #39.
    b. Topcoat: Latex, interior, high performance architectural, (Gloss Level 2), MPI #138.
    c. Topcoat: Latex, interior, high performance architectural, (Gloss Level 3), MPI #139.
    d. Topcoat: Latex, interior, high performance architectural, (Gloss Level 4), MPI #140.

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e. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

5. Alkyd System:

a. Prime Coat: Primer sealer, alkyd, interior, MPI #45.
b. Topcoat: Alkyd, interior, flat (Gloss Level 1), MPI #49.
c. Topcoat: Alkyd, interior, (Gloss Level 3), MPI #51.
d. Topcoat: Alkyd, interior, semi-gloss (Gloss Level 5), MPI #47.
e. Topcoat: Alkyd, interior, gloss (Gloss Level 6), MPI #48.

F. Gypsum Board Substrates:

1. Latex System:

a. Prime Coat: Primer sealer, latex, interior, MPI #50.
b. Prime Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
d. Topcoat: Latex, interior, (Gloss Level 2), MPI #44.
e. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.
f. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
g. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.
h. Topcoat: Latex, interior, gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.

2. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
b. Topcoat: Latex, interior, institutional low odor/VOC, flat (Gloss Level 1), MPI #143.
c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 2), MPI #144.
d. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.
e. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (Gloss Level 5), MPI #147.

3. High-Performance Architectural Latex System:

a. Prime Coat: Primer sealer, latex, interior, MPI #50.
b. Topcoat: Latex, interior, high performance architectural, (Gloss Level 2), MPI #138.
c. Topcoat: Latex, interior, high performance architectural, (Gloss Level 3), MPI #139.
d. Topcoat: Latex, interior, high performance architectural, (Gloss Level 4), MPI #140.
e. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

4. Water-Based Light Industrial Coating System:

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a. Prime Coat: Primer sealer, latex, interior, MPI #50.
b. Topcoat: Light industrial coating, interior, water based (Gloss Level 3), MPI #151.
c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5), MPI #153.
d. Topcoat: Light industrial coating, interior, water based, gloss (Gloss Level 6), MPI #154.

5. Alkyd over Latex Primer System:

a. Prime Coat: Primer sealer, latex, interior, MPI #50.
b. Topcoat: Alkyd, interior, flat (Gloss Level 1), MPI #49.
c. Topcoat: Alkyd, interior, (Gloss Level 3), MPI #51.
d. Topcoat: Alkyd, interior, semi-gloss (Gloss Level 5), MPI #47.
e. Topcoat: Alkyd, interior, gloss (Gloss Level 6), MPI #48.

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 099123

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SECTION 099600 - HIGH-PERFORMANCE COATINGS

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 surface preparation and application of high-performance coating systems. on the following substrates:

1. Exterior Substrates:
   a. Steel.
   b. Galvanized metal.

2. Interior Substrates:
   a. Steel.
   b. Galvanized metal.

B. Related Requirements:
1. Section 099123 "Interior Painting" for special-use coatings and general field painting.

1.3 DEFINITIONS

A. Semi-Gloss: 30 to 65 units at 60 degrees, according to ASTM D16.

B. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

C. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

D. Environments: The following terms are used in Part 2 of this Section to distinguish between different corrosive exposures:

1. "Severe environments" are highly corrosive industrial atmospheres with sustained exposure to high humidity and condensation and with frequent cleaning using strong chemicals. Environments with heavy concentrations of strong chemical fumes and frequent splashing and spilling of harsh chemical products are severe environments.
2. "Moderate environments" are corrosive industrial atmospheres with intermittent exposure to high humidity and condensation, occasional mold and mildew development, and regular cleaning with strong chemicals. Environments with exposure to heavy concentrations of chemical fumes and occasional splashing

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and spilling of chemical products are moderate environments.

3. "Mild environments" are industrial atmospheres with normal exposure to moderate humidity and condensation, occasional mold and mildew development, and infrequent cleaning with strong chemicals. Environments with low levels of mild chemical fumes and occasional splashing and spilling of chemical products are mild environments. Normal outdoor weathering is also considered a mild environment.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference the specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each material specified.

3. Certification by manufacturer that products supplied comply with requirements indicated that limit the amount of VOCs in coating products.
4. Include data substantiating that materials comply with requirements.

B. Samples for Verification: For each type of coating system and in each color and gloss of topcoat indicated, with texture to simulate actual conditions, on representative samples of the actual substrate.

1. Provide stepped Samples defining each separate coat, including primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
2. List of material and application for each coat of each sample. Label each sample for location and application.
3. Submit Samples on rigid backing, 8 inches (200 mm) square, unless otherwise noted.
4. Label each coat of each Sample.
5. Label each Sample for location and application area.
6. Submit samples on the following substrates for DEN Project Manager's review of color and texture:
   a. Ferrous and Nonferrous Metal: Provide two 4-inch- square samples of flat metal and two 8-inch- long samples of solid metal for each color and finish.

C. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

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3. VOC content.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Package coating materials in unopened, factory-sealed containers for storage and identify with labels describing contents.

1. Coatings: Five (5) percent, but not less than 1 gal. (3.8 L)of each material and color applied.

1.7 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed high-performance coating system applications similar in material and extent to those indicated for Project and whose work has a record of successful in-service performance.

B. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.

C. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Duplicate finish of approved sample Submittals.

1. DEN Project Manager will select one surface to represent surfaces and conditions for application of each coating system specified in Part 3.

   a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
   b. Other Items: DEN Project Manager will designate items or areas required.

2. After permanent lighting and other environmental services have been activated, apply coatings in this room or to each surface as specified. Provide the required sheen, color, and texture of each surface.

   a. After finishes are accepted, DEN Project Manager will use the room or surface to evaluate coating systems of a similar nature.

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3. Final approval of color selections will be based on mockups.

    a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by DEN Project Manager at no added cost to Owner.

4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless DEN Project Manager specifically approves such deviations in writing.
5. Subject to compliance with requirements, and if approved by DEN Project Manager, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label with the following information:
    1. Name or title of material.
    2. Product description (generic classification or binder type).
    3. Manufacturer's stock number and date of manufacture.
    4. Contents by volume, for pigment and vehicle constituents.
    5. Thinning instructions.
    6. Application instructions.
    7. Color name and number.
    8. Handling instructions and precautions.

B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

    1. Maintain containers in clean condition, free of foreign materials and residue.
    2. Remove rags and waste from storage areas daily.
    3. Protect materials from freezing. Keep storage area neat and orderly.
    4. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and applying coatings.
    5. All storage methods to comply with requirements of governing authorities.

1.9 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply coatings or when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

C. Do not apply exterior coatings in snow, rain, fog, or mist.

D. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.

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E. Work may continue during inclement weather only if areas and surfaces to be coated are enclosed and temperature within the area can be maintained within limits specified by manufacturer during application and drying periods.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Behr Process Corporation.
2. Benjamin Moore & Co.
3. Carboline Company.
4. Conco Paints.
5. Coronado Paint.
6. Diamond Vogel Paints.
7. Dunn-Edwards Corporation.
8. DuPont Company.
9. ICI Paints.
10. International Protective Coatings; Courtaulds Coatings (International).
11. Kelly-Moore Paints.
12. PARA Paints.
13. PPG Architectural Finishes, Inc.
14. Pratt & Lambert.
15. Rust-Oleum Corporation.
16. Sherwin-Williams Company (The).
17. Tnemec Company, Inc.
18. or approved equal.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and are listed in "MPI Approved Products List."

B. Material Quality: Provide manufacturer's highest grade of the various high-performance coatings specified. Materials not displaying manufacturer's product identification are not acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Material Compatibility:

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1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.
3. Provide products of same manufacturer for each coat in a coating system.

D. Colors: As selected by DEN Project Manager from manufacturer's full range .

2.3 METAL PRIMERS

A. Primer, Zinc-Rich, Inorganic: MPI #19.

B. Primer, Epoxy, Anti-Corrosive, for Metal: MPI #101.

2.4 EPOXY COATINGS

A. Epoxy, Gloss: MPI #77.

2.5 POLYURETHANE COATINGS

A. Polyurethane, Two-Component, Pigmented, Gloss (Gloss Level 6): MPI #72.

2.6 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

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PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

D. Coordination of Work: Review other Sections in which primers or other coatings are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of specified finish materials to ensure compatible primers.

1. If a potential incompatibility of primers applied by others exists, obtain the following from the primer Applicator before proceeding:

a. Confirmation of primer's suitability for expected service conditions.
b. Confirmation of primer's ability to be top coated with materials specified.

2. Notify DEN Project Manager about anticipated problems before using the coatings specified over substrates primed by others.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

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D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer. but not less than the following:

1. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
2. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
3. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
5. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

G. Material Preparation: Carefully mix and prepare coating materials in strict accordance to manufacturer's written instructions.

1. Maintain containers used in mixing and applying coatings in a clean condition, free of foreign materials and residue.
2. Stir materials before applying to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into the material. Remove film and, if necessary, strain coating material before using.
3. Use only the type of thinners approved by manufacturer and only within recommended limits.

H. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coating colors, surface treatments, and finishes are indicated in the coating system descriptions.
3. Provide finish coats compatible with primers used.
4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, grilles, covers for finned-tube radiation, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
5. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.

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6. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
7. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Application Procedures: Apply coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brush Application: Use brushes best suited for material applied and of appropriate size for the surface or item being coated.

    a. Apply primers and first coats by brush unless manufacturer's written instructions permit using roller or mechanical applicators.
    b. Brush out and work brush coats into surfaces in an even film.
    c. Eliminate cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Neatly draw glass lines and color breaks.

2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by manufacturer for the material and texture required.
3. Spray Equipment: Use mechanical methods to apply coating if permitted by manufacturer's written instructions and governing regulations.

    a. Use spray equipment with orifice size recommended by manufacturer for material and texture required.
    b. Apply each coat to provide the equivalent hiding of brush-applied coats.
    c. Do not double back with spray equipment building-up film thickness of two coats in one pass, unless recommended by manufacturer.

4. Minimum Coating Thickness: Apply each material no thinner than manufacturer's recommended spreading rate. Provide total dry film thickness of the entire system as recommended by manufacturer.
5. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.
6. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by manufacturer, to material required to be coated or finished that has not been prime coated by others.

    a. Recoat primed and sealed substrates if there is evidence of suction spots or unsealed areas in first coat, to ensure a finish coat with no burn-through or other defects caused by insufficient sealing.

C. Completed Work: Match approved Samples for color, texture, and coverage. Remove, re-finish, or recoat work that does not comply with specified requirements.

D. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

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E. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

F. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner will engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

B. Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when coatings are being applied:

1. Owner will engage the services of a qualified testing agency to sample coating material being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform appropriate tests for the following characteristics as required by Owner:
    a. Quantitative materials analysis.
    b. Absorption.
    c. Accelerated weathering.
    d. Accelerated yellowness.
    e. Color retention.
    f. Alkali and mildew resistance.
    g. Abrasion resistance.
    h. Apparent reflectivity.
    i. Washability.
    j. Dry opacity.
    k. Recoating.
    l. Skinning.

3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with specified requirements. Contractor shall remove non-complying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. If necessary, Contractor may be required to remove rejected materials from previously coated surfaces if, on recoating with specified materials, the two coatings are not compatible.

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3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by DEN Project Manager, and leave in an undamaged condition.

1. Provide "Wet Paint" signs to protect newly coated finishes. After completing coating operations, remove temporary protective wrappings provided by others to protect their work.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

1. Comply with procedures specified in PDCA P1.

3.6 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Steel Substrates:

1. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
b. Intermediate Coat: Epoxy, gloss, MPI #77.
c. First Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.
d. Second Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

2. Pigmented Polyurethane over Epoxy System:

a. Prime Coat: Primer, epoxy, as recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. First Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

3. Pigmented Polyurethane over High-Build Epoxy System:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
b. Intermediate Coat: Epoxy, high-build, low gloss, MPI #108.
c. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

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4. Pigmented Polyurethane over High-Build Epoxy System:

    a. Prime Coat: Primer, epoxy, as recommended in writing by topcoat manufacturer.
    b. Intermediate Coat: Epoxy, high-build, low gloss, MPI #108.
    c. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

5. Pigmented Polyurethane over Inorganic Zinc-Rich Primer and High-Build Epoxy System:

    a. Prime Coat: Primer, zinc-rich, inorganic, MPI #19.
    b. Intermediate Coat: Epoxy, high-build, low gloss, MPI #108.
    c. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

B. Galvanized-Metal Substrates:

1. Pigmented Polyurethane System:

    a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
    b. Intermediate Coat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.
    c. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

2. Pigmented Polyurethane System:

    a. Prime Coat: Primer, epoxy, as recommended in writing by topcoat manufacturer.
    b. Intermediate Coat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.
    c. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

3.7 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Steel Substrates:
    a. .

2. Pigmented Polyurethane System:

    a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
    b. Intermediate Coat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.
    c. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

3. Pigmented Polyurethane over Inorganic Zinc-Rich Primer System:

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a. Prime Coat: Primer, zinc-rich, inorganic, MPI #19.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

B. Galvanized-Metal Substrates:

1. Pigmented Polyurethane System:

a. Prime Coat: Primer, epoxy, as recommended in writing by topcoat manufacturer.
b. Intermediate Coat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.
c. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.

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 099600

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SECTION 316329.10 - DRILLED CONCRETE MICROPILES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Dry-installed micropiles.
2. Slurry displacement-installed micropiles.
3. Dry-installed or slurry displacement-installed micropiles at Contractor's choice.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 UNIT PRICES

A. Micropiles: Actual net volume of micropiles in place and approved. Actual length, shaft diameter, may vary, to coincide with elevations where satisfactory bearing strata are encountered. These dimensions may also vary with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments are made on net variation of total quantities, based on design dimensions for shafts.

1. Base bids on indicated number of micropiles and, for each, the design length from top elevation to bottom of shaft, and the diameter of the shaft.
2. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, testing and inspecting, and other items for complete micropile installation.

B. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed outside dimensions of drilled piers cast against rock. Unit prices for rock excavation include replacement with approved materials.

C. Trial Micropile: Same unit price as indicated for micropile, including backfilling.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site location and time as determined by DEN Project Manager.

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1. Review methods and procedures related to micropiles including, but not limited to, the following:

    a. Review geotechnical report.
    b. Discuss existing utilities and subsurface conditions.
    c. Review coordination with temporary controls and protections.
    d. Review measurement and payment of unit prices.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data substantiating that materials comply with requirements.

B. Design Mixtures: For each concrete mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Shop Drawings: For concrete reinforcement, detailing fabricating, bending, supporting, and placing.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer [land surveyor] [professional engineer] [and] [testing agency].

B. Welding certificates.

C. Material Certificates: From manufacturer, for the following:

1. Cementitious materials.
2. Admixtures.
3. Steel reinforcement and accessories.

D. Material Test Reports: For each material below, by a qualified testing agency:

1. Aggregates:[Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.]

E. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

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1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in micropile work.

B. Testing Agency Qualifications: Qualified according to ASTM C 1077, ASTM D 3740, and ASTM E 329 for testing indicated.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

1.9 TRIAL MICROPILE

A. Trial Micropile: Construct trial micropile of diameter and depth and at location indicated or, if not indicated, of same diameter and depth as largest micropile, located at least three diameters clear of permanent drilled piers, to demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.

1. Install reinforcement, fill with concrete, remove temporary casings, and terminate trial drilled pier 24 inches (600 mm) below subgrade and leave in place.
2. Install permanent casings, and place slurry, as required for permanent micropiles.
3. If Architect determines that trial micropile does not comply with requirements, excavate for and cast another until it is accepted.

1.10 FIELD CONDITIONS

A. Existing Utilities: Locate existing underground utilities before excavating micropiles. If utilities are to remain in place, provide protection from damage during drilled-pier operations.

1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.

B. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Owner's written permission.

C. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and

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results of analyses conducted by geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for micropiles.
2. The geotechnical report is included elsewhere in the Project Manual.

D. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for micropiles. Before excavating, lay out each micropile to lines and levels required. Record actual measurements of each micropile's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each micropile and indicate on record Drawings. Cooperate with Owner's testing and inspecting agency to provide data for required reports.

1.11 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Drilled-Pier Standard: Comply with ACI 336.1 except as modified in this Section.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 or Grade 75 or ASTM A722, Grade 150, deformed.

1. Bar Couplers : shall develop the ultimate tensile stress of the bar, without any evidence of failure. For compressive loading, the coupler shall be compatible with efficient load transfer and overall reinforcement performance requirements.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150/C 150M, Type I/II

a. Fly Ash: ASTM C 618, Class C or Class F.

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b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregate:

1. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

D. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
3. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
4. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
5. Air-Entraining Admixture: ASTM C 260.

E. Sand-Cement Grout: Portland cement, ASTM C 150/C 150M, Type II; clean natural sand, ASTM C 404; and water to result in grout with a minimum 28-day compressive strength of 1000 psi (6.9 MPa), of consistency required for application.

2.4 STEEL CASINGS

A. Steel Pipe Casings: ASTM A 252/A 252M, Grade 3.

2.5 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301 (ACI 301M).

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 (ACI 301M) limits as if concrete were exposed to deicing chemicals.

C. The sulfate exposure for all concrete shall be class 2 unless otherwise specified in the plans. A higher level requirement may be used for a lower level of exposure. If the Contractor provides test reports that show another class of exposure exists at a structure location, than the Engineer may accept concrete mix for that location that meets the corresponding sulfate protection requirements. Contractor shall refer to Table 601-2 of the CDOT Standard Specifications for Road and Bridge Construction 2017.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

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E. Proportion normal-weight concrete mixture as follows:

1. Compressive Strength (28 Days): 4500 psi (31 MPa)].
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Minimum Slump: Capable of maintaining the following slump until completion of placement:

   a. 4 inches (100 mm) for dry, uncased, or permanent-cased drilling method.
   b. 6 inches (150 mm) for temporary-casing drilling method.
   c. 7 inches (175 mm) for slurry displacement method.

4. Air Content: Do not air entrain concrete, or as specified by the Engineer.

2.6 REINFORCEMENT FABRICATION

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2 EXCAVATION

A. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.

1. Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time are authorized for removal of obstructions.
2. Obstructions: Unclassified excavated materials may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions.

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Payment for removing obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work is according to Contract provisions for changes in the Work.

B. Classified Excavation: Excavation is classified as standard excavation, special excavation, and obstruction removal and includes excavation to bearing elevations as follows:

1. Standard excavation includes excavation accomplished with conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work.
2. Special excavation includes excavation that requires special equipment or procedures where drilled-pier excavation equipment used in standard excavation, operating at maximum power, torque, and downthrust, cannot advance the shaft.

    a. Special excavation requires use of special rock augers, core barrels, air tools, blasting, or other methods of hand excavation.
    b. Earth seams, rock fragments, and voids included in rock excavation area are considered rock for full volume of shaft from initial contact with rock.

3. Obstructions: Payment for removing unanticipated boulders, concrete, masonry, or other subsurface obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work is according to Contract provisions for changes in the Work.

C. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.

D. Excavate shafts for micropiles to indicated elevations. Remove loose material from bottom of excavation.

1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
2. Remove water from excavated shafts before concreting.
3. Excavate rock sockets of dimensions indicated.
4. Cut series of grooves about perimeter of shaft to height from bottom of shaft, vertical spacing, and dimensions indicated.

E. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.

1. Do not excavate shafts deeper than elevations indicated unless approved by Architect.
2. Payment for additional authorized excavation is according to Contract provisions for changes in the Work.

F. End-Bearing Drilled Piers: Probe with auger to a depth below bearing elevation, equal to diameter of the bearing area of drilled pier. Determine whether voids, clay seams, or

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solution channels exist.

1. Test first three drilled piers and one of every six drilled piers thereafter.
2. Fill augur-probe holes with grout.

G. End-Bearing Drilled Piers: Probe with auger to a depth of 96 inches (2450 mm) below bottom elevation of shaft, and visually inspect and classify soil. Verify continuity and thickness of strata.

1. Test first three drilled piers and one of every six drilled piers thereafter.

H. Excavate shafts for closely spaced drilled piers and for drilled piers occurring in fragile or sand strata only after adjacent drilled piers are filled with concrete and allowed to set.

I. Slurry Displacement Method: Stabilize excavation with slurry maintained a minimum of 60 inches (1500 mm) above ground-water level and above unstable soil strata to prevent caving or sloughing of shaft. Maintain slurry properties before concreting.

1. Excavate and complete concreting of drilled pier on same day, or redrill, clean, and test slurry in excavation before concreting.

J. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.

1. Casings shall be removed unless otherwise designated on the plans. Casings shall be removed in a manner such that voids between the excavation and the casing will be completely filled with fresh concrete. The removal method shall prevent the intrusion of water, sloughing of the excavation, displacement of the reinforcing steel, and lifting of the concrete.

K. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit corrective construction proposals to Architect for review before proceeding.

3.3 PERMANENT STEEL CASING INSTALLATION

A. Install permanent steel casings of minimum wall thickness indicated and of diameter not less than diameter of micropile.

1. At the top of each pile, permanent steel casing is required. The casing shall extend 1.2 times the pile’s flexural length as determined by the micropile subcontractor using L-pile analysis (or equivalent analysis approved by the NPS). Analysis shall consider existing soil types, micropile construction type and size, micropile batter, loads indicated on Drawings, and accidental eccentricity/tolerance of 3” in any plan dimension.
2. Below the casing at the top of the pile, the micropile Contractor shall determine if

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casings are required to meet design strengths. Permanent casing below the casing at the top of the pile is not required as part of work.

3.4 STEEL REINFORCEMENT INSTALLATION

A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.

C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.

D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.

E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.

F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.5 CONCRETE PLACEMENT

A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by a qualified testing agency.

B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.

1. Where concrete cannot be directed down shaft without striking reinforcement, place concrete with chutes, tremies, or pumps.
2. Vibrate top 60 inches (1500 mm) of concrete.

C. Slurry Displacement Method: Place concrete in slurry-filled shafts by tremie methods or pumping. Control placement operations to ensure that tremie or pump pipe is embedded no less than 60 inches (1500 mm) into concrete and that flow of concrete is continuous from bottom to top of drilled pier.

D. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch (1500-mm) head of concrete above bottom of casing.

1. Vibrate top 60 inches (1500 mm) of concrete after withdrawal of temporary casing.

E. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.

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F. Protect concrete work, according to ACI 301 (ACI 301M), from frost, freezing, or low temperatures that could cause physical damage or reduced strength.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

G. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 (ACI 301M) to maintain delivered temperature of concrete at no more than 90 deg F (32 deg C).

1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

3.6 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Micropiles.
2. Excavation.
3. Concrete.
4. Steel reinforcement welding.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Micropile Tests and Inspections: For each micropile, before concrete placement.

1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities are determined by testing and inspecting agency. Final evaluations and approval of data are determined by Architect.

a. Bearing Stratum Tests: Testing agency takes undisturbed rock core samples from drilled-pier bottoms; tests each sample for compression, moisture content, and density; and reports results and evaluations.

D. Grout Tests and Inspections: AASHTO T106/STM C109.

1. Test results for the proposed grout mix completed within one year of the start of work may be submitted for initial verification of the required compressive strengths for installation of pre-production verification test piles and initial production piles. During production, micropile grout shall be tested for compressive strength in accordance with AASHTO T106/ASTM Cl09 at a frequency of no less than one set of three 50-mm grout cubes from each grout plant each day of operation or per every 10 piles, whichever occurs more

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frequently. The compressive strength shall be the average of the 3 cubes tested. Grout consistency as measured by grout density shall be determined by the Contractor per ASTM C 188/AASHTO T 133 or API RP-13B-1 at a frequency of at least one test per pile, conducted just prior to start of pile grouting. The Baroid Mud Balance used in accordance with API RP-13B-1 is an approved device for determining the grout density of neat cement grout. Grout samples shall be taken directly from the grout plant.

2. Tests two cubes each at 3, 7, and 28 days after grouting.
3. Strength of each grout mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi. The minimum compressive strength shall be as specified in the structural design calculations submitted by the Contractor for the micropiles.
4. Report test results in writing to the NPS, concrete manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of grout placement, name of grout testing and inspecting agency, location of grout batch in Work, design compressive strength at 28 days, grout mixture proportions and materials and compressive breaking strength.
5. Additional Tests: Testing and inspecting agency will make additional tests of concrete if test results indicate that consistency, compressive strengths, or other requirements have not been met, as directed by the NPS.
6. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
7. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports for each drilled pier as follows:

1. Actual top and bottom elevations.
2. Actual drilled-pier diameter at top, bottom.
3. Top of rock elevation.
4. Description of soil materials.
5. Description, location, and dimensions of obstructions.
6. Final top centerline location and deviations from requirements.
7. Variation of shaft from plumb.
8. Shaft excavating method.
9. Design and tested bearing capacity of bottom.
10. Depth of rock socket.
11. Levelness of bottom and adequacy of cleanout.
12. Properties of slurry and slurry test results at time of slurry placement and at time of concrete placement.
13. Ground-water conditions and water-infiltration rate, depth, and pumping.
14. Description, purpose, length, wall thickness, diameter, tip, and top and bottom elevations of temporary or permanent casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.
15. Description of soil or water movement, sidewall stability, loss of ground, and

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means of control.

16. Date and time of starting and completing excavation.
17. Inspection report.
18. Condition of reinforcing steel and splices.
19. Position of reinforcing steel.
20. Concrete placing method, including elevation of consolidation and delays.
21. Elevation of concrete during removal of casings.
22. Locations of construction joints.
23. Concrete volume.
24. Concrete testing results.
25. Remarks, unusual conditions encountered, and deviations from requirements.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

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.

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DESIGN CONTRACT NO. : 201732333 T014

CONFORMED SET

CCA & CCC
PCA PLANTS RE-LIFE

SPECIFICATIONS
VOLUME 2

21 MAY 2020

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CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION

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DIVISION 23 – HEATING, VENTING AND AIRCONDITIONING

230400 Basic HVAC Requirements
230500 Common Work Results for HVAC Equipment
230505 Selective Demolition for Mechanical
230513 Common Motor Requirements for HVAC Equipment
230517 Sleeves and Sleeve Seals for HVAC Piping
230523.12 Ball Valves for HVAC Piping
230523.13 Butterfly Valves for HVAC Piping
230523.14 Check Valves for HVAC Piping
230529 Hangers and Supports for HVAC Piping and Equipment
230553 Identification for HVAC Piping and Equipment
230593 Testing, Adjusting and Balancing for HVAC
230719 HVAC Piping Insulation'
230800 Commissioning of HVAC
230923 Direct Digital Control (DDC) System for HVAC
230923.11 Control Valves
230923.14 Flow Instruments
230923.22 Position Instruments
230923.23 Pressure Instruments
230923.27 Temperature Instruments
230993.11 Sequence of Operations for HVAC DDC
232113 Hydronic Piping
232116 Hydronic Piping Specialties
231123 Hydronic Pumps
233113 Metal Ducts
233300 Air Duct Accessories
236411 Packaged Water Chillers – Reciprocating Scroll & Screw
236600 Preconditioned Air Hydronic Air Handling Units – Aviation
236616 Preconditioned Air Electric Control Systems – Aviation
236619 Preconditioned Air Sequence of Operation – Aviation
238219 Fan Coil Units

DIVISION 26 – ELECTRICAL

260400 Basic Electrical Requirements
260505 Selective Demolition for Electrical
260510 Testing, Acceptance and Certification
260519 Low-voltage electrical power conductors and cables
260526 Grounding and Bonding for Electrical Systems
260529 Hangers and Supports for Electrical Systems
260533 Raceways and Boxes for Electrical Systems
260544 Sleeves and Sleeve Seals for Electrical Raceways and Cabling
260548 Vibration and Seismic Controls for Electrical Systems
260553 Identification for Electrical Systems
260573 Arc Flash and Overcurrent Protective Device Coordination Study
260583 Electrical Connections for Equipment
260800 Commissioning of Electrical Systems
260923 Lighting Control Devices
262413 Switchboards
262416 Panelboards

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262713 Electricity Metering
262726 Wiring Devices
262813 Fuses
262816 Enclosed Switches and Circuit Breakers
262923 Variable-Frequency Motor Controllers
265100 Interior Lighting

DIVISION 27 – COMMUNICATIONS
275123 Emergency Communications System

DIVISION 28 – ELECTRIC SAFETY AND SECURITY
283100 Intelligent Life Safety Fire Management System

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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, 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.

E. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

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.

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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.

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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".

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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 DEN 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 DEN 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 DEN 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

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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 DEN property to a DEN 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 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 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 DEN 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.

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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: Section 024119 "Selective Demolition".

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 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.

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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 DEN 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 DEN 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 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 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 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.

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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 that have been 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.

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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

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SECTION 230500 - COMMON WORK RESULTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Sleeves.
5. Escutcheons.
6. Nonshrink grout for equipment installations.
7. Flowable backfill for underground piping.
8. Field-fabricated metal equipment supports.
9. Concrete bases
10. Installation requirements common to equipment specification Sections.
11. Mechanical demolition.
12. Cutting and patching.
13. Touch up painting and finishing.
14. 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.

1.3 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 230400 "Basic Mechanical Requirements".

C. Division 31 Earthwork Sections.

D. Section 059990 "Welding".

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E. Section 230553 "Identification for HVAC Piping and Equipment" for labeling and identifying mechanical systems and equipment.

1.4 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.

1.5 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 013300 "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: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures" .

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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" x 36" or 34" x 44". Spool drawings shall be submitted in in accordance with requirements as specified in Section 013300 "Submittal Procedures". . Adobe Acrobat 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 23 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.

1.6 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 DEN 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. Electronic Equipment Compliance:

1. Contractor warrants that all equipment, devices, items, systems, software, hardware, or firmware provided shall properly, appropriately, and consistently function and accurately process date and time data (including without limitation: calculating, comparing, and sequencing). This warranty supersedes anything in the Specifications or other Contract Documents that might be construed inconsistently. This warranty is applicable whether the equipment, device, item, system, software, hardware, or firmware is specified with or without reference to a manufacturer's name, make, or model number.

C. 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.

1.7 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 ductwork, pipes, and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

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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 ductwork and fittings with plastic sheeting to protect it from elements. Inspect duct liner for exposure to dirt and tears.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Coordinate the installation of required supporting devices.

C. Sequence, coordinate, and integrate installations of mechanical 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

2.1 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.

2.2 JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 23 for special joining materials not listed below.

B. Grooved Mechanical Couplings: Acceptable only for fire protection piping; not acceptable for any other applications.

C. 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.

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D. 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.

E. Brazing Filler Metals: AWS A5.8.

1. BCuP Series: Copper-phosphorus alloys.
2. BAg1: Silver alloy.

F. 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.

2.3 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.

2.4 MECHANICAL SLEEVE SEALS

A. Reference Section 230517 "Sleeves and Sleeve Seals for HVAC Piping" for sleeve seals.

2.5 SLEEVES

A. Reference Section 230517 "Sleeves and Sleeve Seals for HVAC Piping" for sleeves.

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2.6 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.

1. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory-packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 23 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

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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 312323.33 "Flowable Backfill (Controlled Low-Strength Concrete)" for material and installation requirements.

3.2 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 DEN 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.

3.3 PAINTING AND FINISHING

A. Refer to Division 09 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

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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 Division 09.

3.4 CONCRETE PENETRATIONS

A. Reference Section 017329 "Cutting and Patching" for core drilling and saw cutting requirements.

B. Reference Section 017329 "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 DEN Project Manager before proceeding with drilling.

3.5 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to current seismic codes at Project location.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use [**3000-psi**] <**Insert other**>, 28-day compressive-strength concrete and reinforcement as specified in Division 03.

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3.6 WELDING

A. Qualify welding processes and operators for structural steel according to AWS D1.1 Structural Welding Code - Steel. See Division 5 sections 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.

3.7 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.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 DEMOLITION

A. Refer to Division 01 and Division 02 Sections 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

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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. Ducts to Be Removed: Remove portion of ducts and associated supports indicated to be removed and plug remaining ducts with same or compatible ductwork material. No ductwork shall be abandoned in place. Repair insulation.
3. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
8. 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.
9. Repair structure floor, ceilings, roof, slabs from removed supports in accordance with Division 03,GROUTING

E. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

F. Clean surfaces that will come into contact with grout.

G. Provide forms as required for placement of grout.

H. Avoid air entrapment during placement of grout.

I. Place grout, completely filling equipment bases.

J. Place grout on concrete bases and provide smooth bearing surface for equipment.

K. Place grout around anchors.

L. Cure placed grout.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

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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 applicable unit price item, work order or lump sum bid item.

END OF SECTION 230500

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SECTION 230505 - SELECTIVE DEMOLITION FOR MECHANICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Removal of designated building equipment and fixtures.

B. Removal of designated construction.

C. Disposal of materials.

D. Identification of utilities

1.3 RELATED SECTIONS

A. Section 011000 "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.

B. Section 024119 "Selective Demolition" for demolition and removal of selected site elements.

C. Section 210400 "Basic Fire Suppression Requirements"

D. Section 220400 "Basic Plumbing Requirements."

E. Section 230400 "Basic HVAC Requirements."

F. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements.

1.4 ALTERNATES

A. Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

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1.5 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of capped utilities,and subsurface obstructions..

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 drawing.

1.6 REGULATORY REQUIREMENTS

A. Do not disable or disrupt building fire or life safety systems without 5 business days prior written notice and written acceptance of DEN Project Manager and DEN Life Safety Team.

B. Conform to procedures applicable when hazardous or contaminated materials are discovered.

1.7 SCHEDULING

A. Schedule Work to coordinate with work of other trades and new construction.

1.8 PROJECT CONDITIONS

A. Conduct demolition to minimize interference with adjacent and occupied building areas.

B. Cease operations immediately if structure appears to be in danger and notify DEN Project Manager. Do not resume operations until directed.

PART 2 - PRODUCTS {NOT USED}

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide, erect, and maintain temporary barriers at locations indicated.

B. Erect and maintain weatherproof closures for exterior openings.

C. Protect existing materials and systems, which are not to be demolished.

D. Notify affected utility companies before starting work and comply with their requirements.

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E. Mark location and termination of utilities.

3.2 DEMOLITION

A. Existing mechanical systems, including piping, ductwork, or tubing, shall not be abandoned in place.

B. Disconnect remove, cap, and identify designated utilities within demolition areas.

C. Demolish in an orderly and careful manner. Remove all unused piping, ductwork, or tubing back to source and cap.

D. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

E. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

F. Remove temporary Work.

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 **230505**

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SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

1.4 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

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2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

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1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

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.

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SECTION 230517 - SLEEVES AND SLEEVE SEALS 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, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

C. Product Data: For each type of product indicated.

1. Include data substantiating that materials comply with requirements.

1.3 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 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

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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 minimum thickness; round tube closed with welded longitudinal joint.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 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.

2.3 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.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

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2.4 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.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi , 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 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 as new slabs and walls are constructed.

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.

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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. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

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. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
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. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 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.

3.4 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

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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.

3.5 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: Cast-iron wall sleeves.
b. Piping NPS 6 and Larger: Cast-iron wall sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6: Cast-iron 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.

b. Piping NPS 6 and Larger: Cast-iron 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

4.1 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.

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SECTION 230523.12 - BALL 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, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Steel ball valves.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and accessory. Provide manufacturers catalog information. Indicate valve data and ratings.

   1. Include data substantiating that materials comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

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 valves.

1.6 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

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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.

1.7 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. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. 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.
3. Provide temporary protective coating on cast iron and steel valves.
4. Provide temporary end caps and closures on fittings. Maintain in place until installation.
5. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

D. 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.

1.8 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

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.

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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. Refer to HVAC valve schedule articles for applications of valves.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
2. Handlever: For quarter-turn valves smaller than NPS 4 .

G. 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.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 STEEL BALL VALVES

A. Class 150 Steel Ball Valves with Full Port and Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.; Apollo Valves.
b. Jamesbury; a subsidiary of Metso Automation.
c. NIBCO INC.
d. or approved equal.

2. Description:

a. Standard: MSS SP-72.
b. CWP Rating: 285 psig .
c. Body Design: Split body.
d. Body Material: Carbon steel, ASTM A 216, Type WCB.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.

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i. Port: Full.

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 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.

3.3 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. Provide dielectric fittings wherever jointing dissimilar metals.

C. Locate valves for easy access and provide separate support where necessary.

D. Provide clearance for installation of insulation and access to valves and fittings.

E. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 08 installer.

F. Install valves with stems upright or horizontal, not inverted.

G. Lever Handle Valves: Install valve handle so that the handle opens in the direction of

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fluid flow.

H. Install valves in horizontal piping with stem at or above center of pipe.

I. Install valves in position to allow full stem movement.

J. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.4 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 Steel Piping, NPS 2 and Smaller: Threaded ends.
2. For Steel Piping, NPS 2-1/2 to NPS 4 : Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Three piece, full port, steel with stainless-steel trim.

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Three piece, full port, steel with stainless-steel trim.

3.7 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Three piece, full port, steel with stainless-steel trim.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

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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 230523.12

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SECTION 230523.13 - BUTTERFLY 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, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. High-performance butterfly valves.
   2. Chainwheels.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and accessory. Provide manufacturers catalog information. Indicate valve data and ratings.

   1. Include data substantiating that materials comply with requirements.

1.5 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. Record actual locations of valves.

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1.6 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set butterfly valves closed or slightly open.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. 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.

D. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.8 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

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 B16.1 for flanges on iron valves.
2. ASME B16.5 for pipe flanges and flanged fittings, NPS 1/2 through NPS 24.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

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4. ASME B31.1 for power piping valves.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Types:

1. Gear Actuator: For valves NPS 8 and larger.
2. Handlever: For valves NPS 6 and smaller.
3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.

G. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

2.2 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bray Controls; a division of Bray International.
   b. Jamesbury; a subsidiary of Metso Automation.
   c. Tyco Valves & Controls; a unit of Tyco Flow Control.
   d. Fisher, a subsidiary of Emerson.
   e. or approved equal.

2. Description:

   a. Standard: MSS SP-68.
   b. CWP Rating: 285 psig at 100 deg F .
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
   e. Seat: Reinforced PTFE or metal.
   f. Stem: Stainless steel; offset from seat plane.
   g. Disc: Carbon steel.
   h. Service: Bidirectional.

B. Class 300, Single-Flange, High-Performance Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bray Controls; a division of Bray International.
   b. Jamesbury; a subsidiary of Metso Automation.
   c. Tyco Valves & Controls; a unit of Tyco Flow Control.

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d. Fisher, a subsidiary of Emerson.

2. Description:

a. Standard: MSS SP-68.
b. CWP Rating: 720 psig at 100 deg F .
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel, cast iron, or ductile iron.
e. Seat: Reinforced PTFE or metal.
f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.

2.3 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.
4. or approved equal.

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to hand wheels.

1. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc or epoxy coating.
2. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

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 mating flange faces for damage. 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.

D. Do not attempt to repair defective valves; replace with new valves.

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3.2 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.

3.3 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. Provide dielectric fittings wherever jointing dissimilar metals.

C. Locate valves for easy access and provide separate support where necessary.

D. Provide clearance for installation of insulation and access to valves and fittings.

E. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 08 installer.

F. Install valves with stems upright or horizontal, not inverted.

G. Lever Handle Valves: Install valve handle so that the handle opens in the direction of fluid flow.

H. Install valves in horizontal piping with stem at or above center of pipe.

I. Install valves in position to allow full stem movement.

J. Install chainwheels on operators for butterfly valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches (1520 mm) above finished floor.

K. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.4 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.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
   1. High-Performance Butterfly Valves: Class 150, single flange.

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3.6 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
1. High-Performance Butterfly Valves: Class 150, single flange.

3.7 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
1. High-Performance Butterfly Valves: Class 150, single flange.

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 230523.13

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SECTION 230523.14 - CHECK 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, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Iron swing check valves.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve and accessory. Provide manufacturers catalog information. Indicate valve data and ratings.

   1. Include data substantiating that materials comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

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 valves.

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1.6 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

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.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Block check valves in either closed or open position.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. 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.
3. Provide temporary protective coating on cast iron and steel valves.
4. Provide temporary end caps and closures on fittings. Maintain in place until installation.
5. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

D. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

1.8 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

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:

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1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.1 for power piping valves.
6. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. 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.

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 Bypass and Drain Connections: MSS SP-45.

2.2 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Kitz Corporation.
   f. Legend Valve.
   g. Macomb Groups (The).
   h. Milwaukee Valve Company.
   i. NIBCO INC.
   j. Powell Valves.
   k. Red-White Valve Corporation.
   l. Sure Flow Equipment Inc.
   m. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   n. or approved equal.

2. Description:

   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 12 , CWP Rating: 200 psig .
   c. Body Design: Clear or full waterway.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.

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f. Trim: Bronze.
g. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. or approved equal.

2. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12 , CWP Rating: 200 psig .
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Composition.
g. Seat Ring: Bronze.
h. Disc Holder: Bronze.
i. Disc: PTFE.
j. Gasket: Asbestos free.

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 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

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B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.3 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. Provide dielectric fittings wherever jointing dissimilar metals.

C. Locate valves for easy access and provide separate support where necessary.

D. Provide clearance for installation of insulation and access to valves and fittings.

E. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 08 installer.

F. Install valves with stems upright or horizontal, not inverted.

G. Lever Handle Valves: Install valve handle so that the handle opens in the direction of fluid flow.

H. Install valves in horizontal piping with stem at or above center of pipe.

I. Install valves in position to allow full stem movement.

J. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

K. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

3.4 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.

3.5 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:
   a. NPS 2-1/2 (DN 65) and Larger: Iron swing check valves with lever and

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weight or with spring or iron swing, metal-seat check valves.

B. 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.

C. Select valves, except wafer types, with the following end connections:
1. For Steel Piping, NPS 2-1/2 to NPS 4 : Flanged ends except where threaded valve-end option is indicated in valve schedules.
2. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.6 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
1. Iron Swing Check Valves: Class 125, metal seats.

3.7 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
1. Iron Swing Check Valves: Class 125, metal seats.

3.8 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:
1. Iron Swing Check Valves: Class 125 , metal seats.

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 230523.14

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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, 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. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

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.

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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.

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. 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 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, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.8 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

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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 provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 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 stainless 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.

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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 stainless steel.
7. 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.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

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2.5 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, [**stainless-**] 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.

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.

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.

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

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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 (34.5-MPa), 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.

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D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. 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. See Section 077200 "Roof Accessories" for curbs.

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 (DN 65) 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.

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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 (DN 100) 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 (DN 100) 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. 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.

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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 (40 mm).

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 (0.05 mm).

B. 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.

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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 stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

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 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C), pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), 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 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

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14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), 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 (DN 100 to DN 900), 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 (DN 65 to DN 900) 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 (DN 25 to DN 750), from two 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 (DN 65 to DN 600), 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 (DN 50 to DN 1050) 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 (DN 50 to DN 600) 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 (DN 50 to DN 750) 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 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) 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 (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) 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 (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

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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 (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

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. 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).

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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.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

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

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SECTION 230553 - IDENTIFICATION 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, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 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 Standards" 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.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Provide manufacturers catalog literature for each type of product.

1. Include data substantiating that materials comply with requirements.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

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1. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

C. Valve numbering scheme.

D. 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.

1.5 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. Record actual locations of tagged valves.

1.6 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.

1.7 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Brimar Industries, Inc.
c. Carlton Industries, LP.

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d. Champion America.
e. Craftmark Identification Systems.
f. emedco.
g. Kolbi Pipe Marker Co.
h. LEM Products Inc.
i. Marking Services Inc.
j. Seton Identification Products.
k. or approved equal.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: White.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
7. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. 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), and 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 (A4) bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Actioncraft Products, Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Identification Systems.
7. emedco.

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8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Services Inc.
11. Seton Identification Products.
12. or approved equal.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include 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: Size letters according to ASME A13.1 for piping.

2.3 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Actioncraft Products, Inc.
2. Brady Corporation.
3. Brimar Industries, Inc.
4. Carlton Industries, LP.
5. Champion America.
6. Craftmark Identification Systems.
7. emedco.
8. Kolbi Pipe Marker Co.
9. LEM Products Inc.
10. Marking Services Inc.
11. Seton Identification Products.
12. or approved equal.

B. Description: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or beaded chain.

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C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) 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.

PART 3 - EXECUTION

3.1 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 Division 09 for stencil painting.

3.2 GENERAL INSTALLATION REQUIREMENTS

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.

D. 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).

E. Equipment and terminal devices above ceiling: provide adhesive backed plastic nameplate on ceiling grid support directly below equipment identifying unit tag and temperature control node number.

1. Example:

a. VAV-01 NODE 067.

F. Controls: Identify control panels and major control components outside panels with

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plastic nameplates. Key to control schematics.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Identify piping, concealed or exposed, with plastic pipe markers. Tags may be used on ½" or smaller diameter non-insulated piping. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and "T", at each side of penetration of structure or enclosure, and at each obstruction.

B. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."

C. Pipe Label Locations: 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. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
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 50 feet (15 m) along each run. Reduce intervals to [25 feet (7.6 m)] in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe Label Color Schedule:

1. Chilled-Water Piping: White letters on a safety-green background.
2. Heating Water Piping: White letters on a safety-green background.

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3.5 VALVE-TAG INSTALLATION

A. Identify all valves, including fire protection valves, in main and branch piping located inside the building. Use tags secured with brass 'S' hooks or brass chains.

B. 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.

C. 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.

D. Show valve tag designations on the project record document drawings, including schematic flow diagrams where included with construction documents.

E. 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.

1. Valve-Tag Colors:

   a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
   b. Flammable Fluids: Black letters on a safety-yellow background.
   c. Combustible Fluids: White letters on a safety-brown background.
   d. Potable and Other Water: White letters on a safety-green background.
   e. Compressed Air: White letters on a safety-blue background.
   f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.6 VALVE CHART AND SCHEDULE

A. Provide valve chart and schedule in aluminum frame with clear plastic shield. Install at location as directed by DEN Project Manager.

3.7 PIPING IDENTIFICATION SCHEDULE

A. Pipe identification and color coding for general-use piping systems shall be in accordance with the following schedule. For plumbing piping identification schedule, reference Section 220553 "Identification for Plumbing Piping and Equipment":

Classification	**Band Color**	**Stenciled Legend**
Chilled Water Supply	Green	Ch. Water Supp.
Chilled Water Return	Green	Ch. Water Ret.

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Hot Water Heating Supply	Yellow	H.W. Htg. Supp.
Hot Water Heating Return	Yellow	H.W. Htg. Ret.
Expansion Tank No.	Yellow	Exp. Tank. No.
Glycol Supply (PCA)	Green	Gly. Sup.
Glycol Return (PCA)	Green	Gly. Ret.

PART 4 -

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 230553

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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 Special 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:

2. Constant-volume air systems.

3. Balancing, Testing and Adjusting Hydronic Piping Systems:

    a. Constant-flow hydronic systems.
    b. Variable-flow hydronic systems.

4. Testing, Adjusting, and Balancing Equipment:

    a. Heat exchangers.
    b. Pumps.
    c. Chillers.

5. Sound tests.
6. Vibration tests.
7. Control system verification.

D. Related Sections:

1. Section 014510 "Contractor Quality Control".
2. Section 014520 "Contractor Quality Control for FAA Funded Projects".
3. Section 017515 "System Startup, Testing and Training".
4. Section 230400 "Basic Mechanical Requirements".

E. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in

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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. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.

M. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.

N. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.

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O. 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.

P. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

Q. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

R. 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.

S. TAB: Testing, adjusting, and balancing.

T. TABB: Testing, Adjusting, and Balancing Bureau.

U. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

V. TDH: Total dynamic head.

W. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

X. Test: A procedure to determine quantitative performance of systems or equipment.

Y. 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. Air Diffusion Council (ADC):

    a. Test Code for Grilles, Registers, and Diffusers.

3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):

    a. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and

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Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.

4. International Building Code (IBC) with the Denver Amendments.
5. International Fire Code (IFC) with the Denver Amendments.
6. National Environmental Balancing Bureau (NEBB):

    a. Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

7. 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.

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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. 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.

G. 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 that were used and last date of calibration of each. Report shall include all items listed in PART 3- Execution.

H. A statement outlining all abnormal or notable conditions not covered in above data.

I. 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 30 days 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.

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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".

B. Record actual locations of flow measuring stations and balancing valves and rough setting.

1.10 QUALITY ASSURANCE

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."

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

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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.

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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 terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. 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.

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5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Air coil fins are cleaned and combed.
8. Duct system leakage is minimized.
9. Hydronic systems are flushed, filled, and vented.
10. Pumps are rotating correctly.
11. Proper strainer baskets are clean and in place.
12. Service and balance valves are open.

Q. 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. Airside:

2. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.

3. Duct systems are complete with terminals installed.

4. Volume, smoke, and fire dampers are open and functional.

5. Clean filters are installed.

6. Fans are operating, free of vibration, and rotating in correct direction.

7. Variable-frequency controllers' startup is complete and safeties are verified.

8. Automatic temperature-control systems are operational.

9. Ceilings are installed.

10. Windows and doors are installed.

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11. Suitable access to balancing devices and equipment is provided.

12. 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 nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

L. VAV Boxes (Fan Powered and Shut off): Verify the following and report any

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discrepancies to the responsible installer:

M. Velocity pressure sensor is receiving the proper signal and is then sending that signal to the regulator.

N. Primary air damper will allow design flows without going to end point settings.

O. Thermostats are calibrated.

P. Control pressure is compatible with the primary damper motor range, dead band range and heating electric P.E. or valve motor range.

Q. Direct acting or reverse acting controls are properly installed.

R. Primary fan static pressure controls are receiving the proper signal in their installed location and transmitting this signal to the fan controller.

S. 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.

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. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

D. Verify that motor starters are equipped with properly sized thermal protection.

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3.7 Check condensate drains for proper connections and functioning.Check for proper sealing of air-handling-unit components.Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.8 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

3.9 Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

3.10 Measure fan static pressures to determine actual static pressure as follows:

3.11 Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

3.12 Measure static pressure directly at the fan outlet or through the flexible connection.

3.13 Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection, and downstream from duct restrictions.

3.14 Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3.15 Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and air-treating equipment.

3.16 Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3.17 Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

3.18 First two subparagraphs below may require changes to installed systems or equipment. These changes may require a contract modification.

3.19 Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

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3.20 Obtain approval from DEN Project Manager for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

3.21 Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

3.22 Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

3.23 Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

3.24 Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

3.25 Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

3.26 Measure terminal outlets and inlets without making adjustments.

3.27 Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

3.28 Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

3.29 Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

3.30 Adjust patterns of adjustable outlets for proper distribution without drafts.

3.31 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

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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.

3.32 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.

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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.

3.33 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.

3.34 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

D. Measure inlet steam pressure.

E. Check settings and operation of safety and relief valves. Record settings.

3.35 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.

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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:

1. Test for proper operation at speeds varying from minimum to maximum.
2. Test manual bypass of controller to prove proper operation.
3. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.36 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.37 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:

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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.

3.38 VIBRATION TESTS

A. After systems are balanced and construction is Substantially Complete, measure and record vibration levels on equipment having motor horsepower equal to or greater than 10.

B. Use a vibration meter meeting the following criteria:

1. Solid-state circuitry with a piezoelectric accelerometer.
2. Velocity range of 0.1 to 10 inches per second.
3. Displacement range of 1 to 100 mils.
4. Frequency range of at least 0 to 1000 Hz.
5. Capable of filtering unwanted frequencies.

C. Calibrate the vibration meter before each day of testing.

1. Use a calibrator provided with the vibration meter.
2. Follow vibration meter and calibrator manufacturer's calibration procedures.

D. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.

1. Turn off equipment in the building that might interfere with testing.
2. Clear the space of people.

E. Perform vibration measurements after air and water balancing and equipment testing

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is complete.

F. Clean equipment surfaces in contact with the vibration transducer.

G. Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.

H. Measure and record vibration on rotating equipment over 3 hp.

I. Measure and record equipment vibration, bearing vibration, equipment base vibration, and building structure vibration. Record velocity and displacement readings in the horizontal, vertical, and axial planes.

1. Pumps:

a. Pump Bearing: Drive end and opposite end.
b. Motor Bearing: Drive end and opposite end.
c. Pump Base: Top and side.
d. Building: Floor.
e. Piping: To and from the pump after flexible connections.

2. Fans and HVAC Equipment with Fans:

3. Piping: To and from equipment after flexible connections.

4. Chillers and HVAC Equipment with Compressors:

a. Compressor Bearing: Drive end and opposite end.
b. Motor Bearing: Drive end and opposite end.
c. Equipment Casing: Top and side.
d. Equipment Base: Top and side.
e. Building: Floor.
f. Piping: To and from equipment after flexible connections.

J. For equipment with vibration isolation, take floor measurements with the vibration isolation blocked solid to the floor and with the vibration isolation floating. Calculate and report the differences.

K. Inspect, measure, and record vibration isolation.

1. Verify that vibration isolation is installed in the required locations.
2. Verify that installation is level and plumb.
3. Verify that isolators are properly anchored.
4. For spring isolators, measure the compressed spring height, the spring OD, and the travel-to-solid distance.
5. Measure the operating clearance between each inertia base and the floor or concrete base below. Verify that there is unobstructed clearance between the bottom of the inertia base and the floor.

L. Reporting:

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1. Report shall record location and the system tested.
2. Include horizontal-vertical-axial measurements for tests.
3. Verify that vibration limits follow Specifications, or, if not specified, follow the General Machinery Vibration Severity Chart or Vibration Acceleration General Severity Chart from the AABC National Standards. Acceptable levels of vibration are normally "smooth" to "good."
4. Include in report General Machinery Vibration Severity Chart, with conditions plotted.

3.39 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.

3.40 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
1. Heating-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 airflow rate tolerances shall be identical for each system. (IE: If an AHU is balanced to 97% of design airflow rate, the corresponding exhaust fan should match this 97% tolerance.)

3.41 ADJUSTING

A. Ensure recorded data represents actual measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing

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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.

3.42 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 weekly 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.

3.43 SCHEDULES

A. Equipment Requiring Testing, Adjusting, and Balancing:
   1. HVAC Pumps
   2. Water Chillers
   3. Heat Exchangers

3.44 Air Coils

3.45 Fans

3.46 MOTOR STARTERS AND THERMAL HEATERS

A. Coordinate the requirement for the exchange of thermal overloads as required for proper motor protection on magnetic and manual starters. Check for correct sizing and notify Installers responsible for supply of proper devices of corrections or replacements needed.

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3.47 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 (VAV boxes, 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.

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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. Terminal units.
6. Balancing stations.
7. 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.
    c. V-Belt Drive data including identification/location, required driven RPM; driven sheave (diameter and RPM), belt (size and quality), motor sheave (diameter and RPM), center-to-center distance (maximum, minimum and final).
3. Pump data including identification/number, manufacturer, size/model, impeller, service, flow rate (specified and actual), pressure drop (specified and actual), discharge pressure, suction pressure, total operating head pressure, shut-off (discharge and suction pressures), shut-off (total head pressure), and motor data. Include manufacturer's pump curves.
4. Chiller data including identification/number, manufacturer, capacity, model, evaporator leaving water temperature (specified and actual), evaporator pressure drop (specified and actual), evaporator water flow rate (specified and actual),

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condenser entering water temperature (specified and actual), condenser leaving water temperature (specified and actual), condenser pressure drop (specified and actual), condenser water flow rate (specified and actual), motor amperage.

5. Heat Exchanger data including identification/number, location, service, manufacturer, model, primary water entering temperature (specified and actual), primary water leaving temperature (specified and actual), primary water flow (specified and actual), primary water pressure drop (specified and actual), secondary water entering temperature (specified and actual), secondary water flow (specified and actual), secondary water pressure drop (specified and actual).

6. Vibration Test: Where vibration limitations are specified or shown on the drawings, work shall include measurement and reporting of as-installed systems performance, including the following data:

    a. Location of points:

        1) Fan bearing, drive end.
        2) Fan bearing, opposite end.
        3) Motor bearing, center (if applicable).
        4) Motor bearing, drive end.
        5) Motor bearing, opposite end.
        6) Casing (bottom or top).
        7) Casing (side).
        8) Duct after flexible connection (discharge).
        9) Duct after flexible connection (suction).

    b. Test readings:

        1) Horizontal, velocity, and displacement.
        2) Vertical, velocity, and displacement.
        3) Axial, velocity and displacement.

    c. Normally acceptable readings, velocity, and acceleration.
    d. Unusual conditions at time of test.
    e. Vibration source (if non-complying).

7. Instrument Calibration Reports:

    a. Report Data:

        1) Instrument type and make.
        2) Serial number.
        3) Application.
        4) Dates of use.
        5) Dates of calibration.

8. 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.

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F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm (L/s).
g. Water pressure differential in feet of head or psig (kPa).
h. Required net positive suction head in feet of head or psig (kPa).
i. Pump rpm.
j. Impeller diameter in inches (mm).
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig (kPa).
b. Pump shutoff pressure in feet of head or psig (kPa).
c. Actual impeller size in inches (mm).
d. Full-open flow rate in gpm (L/s).
e. Full-open pressure in feet of head or psig (kPa).
f. Final discharge pressure in feet of head or psig (kPa).
g. Final suction pressure in feet of head or psig (kPa).
h. Final total pressure in feet of head or psig (kPa).
i. Final water flow rate in gpm (L/s).
j. Voltage at each connection.
k. Amperage for each phase.

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.

3.48 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the

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presence of Construction Manager and commissioning authority.

B. Construction Manager and Commissioning authority 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.

3.49 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 water flow of at least 5% of terminals.
   b. Verify that balancing devices are marked with final balance position.
   c. 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

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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.

3.50 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**

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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, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, [**indoors**] [**and**] [**outdoors**].
2. Chilled-water and brine piping, [**indoors**] [**and**] [**outdoors**].
3. Condenser-water piping, [**indoors when used for waterside economizer or for condensate control**] [**and**] [**outdoors**].
4. Heating hot-water piping, [**indoors**] [**and**] [**outdoors**].
5. Steam and steam condensate piping, [**indoors**] [**and**] [**outdoors**].
6. Refrigerant suction and hot-gas piping, [**indoors**] [**and**] [**outdoors**].
7. Dual-service heating and cooling piping, [**indoors**] [**and**] [**outdoors**].
8. Heat-recovery piping, [**indoors**] [**and**] [**outdoors**].
9. Heated fuel-oil piping, [**indoors**] [**and**] [**outdoors**].

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230716 "HVAC Equipment Insulation" for HVAC equipment insulation and high-temperature engine exhaust insulation.
3. Section 232113.13 "Underground Hydronic Piping" for loose-fill pipe insulation in underground piping outside the building.
4. Section 336313 "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product 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.

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B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, 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: 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.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN 50).
2. Sheet Form Insulation Materials: 12 inches (300 mm) square.
3. Jacket Materials for Pipe: 12 inches (300 mm) long by NPS 2 (DN 50).
4. Sheet Jacket Materials: 12 inches (300 mm) square.
5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

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

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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".

1.6 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.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by DEN Project Manager. Use materials indicated for the completed Work.

1. Piping Mockups:

    a. One 10-foot (3-m) section of NPS 2 (DN 50) straight pipe.
    b. One each of a 90-degree threaded, welded, and flanged elbow.
    c. One each of a threaded, welded, and flanged tee fitting.
    d. One NPS 2 (DN 50) or smaller valve, and one NPS 2-1/2 (DN 65) or larger valve.
    e. Four support hangers including hanger shield and insert.
    f. One threaded strainer and one flanged strainer with removable portion of insulation.
    g. One threaded reducer and one welded reducer.
    h. One pressure temperature tap.
    i. One mechanical coupling.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify DEN Project Manager seven (7) days in advance of dates and times when mockups will be constructed.
4. Obtain DEN Project Manager's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless DEN Project Manager specifically approves such deviations in writing.

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6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

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 provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

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PART 2 - PRODUCTS

2.1 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. Calcium Silicate:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Industrial Insulation Group (IIG); Thermo-12 Gold.
    b. <**Insert manufacturer's name; product name or designation**>.
    c. 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. 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. <**Insert manufacturer's name; product name or designation**>.
    c. or approved equal.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.

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4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied [**ASJ**] [**ASJ-SSL**]: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

H. 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. <**Insert manufacturer's name; product name or designation**>.
   e. or approved equal.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type [**I**] [**II with factory-applied vinyl jacket**] [**III with factory-applied FSK jacket**] [**III with factory-applied FSP jacket**]. 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.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.
   f. <**Insert manufacturer's name; product name or designation**>.
   g. or approved equal.

J. 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. <**Insert manufacturer's name; product name or designation**>.
   g. or approved equal.

2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, [**without factory-applied jacket**] [**with factory-applied ASJ**] [**with factory-applied ASJ-SSL**]. Factory-applied jacket requirements are specified in "Factory-Applied

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Jackets" Article.

3. Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, [**without factory-applied jacket**] [**with factory-applied ASJ**] [**with factory-applied ASJ-SSL**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. 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. <**Insert manufacturer's name; product name or designation**>.
   d. or approved equal.

L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied [**ASJ**] [**FSK jacket**] 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. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) 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. <**Insert manufacturer's name; product name or designation**>.
   g. or approved equal.

M. Phenolic:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Kingspan Tarec Industrial Insulation NV; Koolphen K.
   b. Resolco International BV; Insul-phen.
   c. <**Insert manufacturer's name; product name or designation**>.
   d. or approved equal.

2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.

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3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

    a. Preformed Pipe Insulation: [**None**] [**ASJ**].

N. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Dow Chemical Company (The); Trymer 2000 XP.
    b. Duna USA Inc.; Corafoam.
    c. Dyplast Products; ISO-25.
    d. Elliott Company of Indianapolis; Elfoam.
    e. <**Insert manufacturer's name; product name or designation**>.
    f. or approved equal.

2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
3. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thickness up to 1 inch (25 mm) as tested by ASTM E 84.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

    a. Pipe Applications: [**None**] [**ASJ**] [**ASJ-SSL**] [**PVDC**] [**PVDC-SSL**].

O. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Armacell LLC; Tubolit.
    b. Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
    c. <**Insert manufacturer's name; product name or designation**>.
    d. or approved equal.

P. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Products: Subject to compliance with requirements, **provide one of the following**:

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a. Dow Chemical Company (The); Styrofoam.
b. <**Insert manufacturer's name; product name or designation**>.
c. or approved equal.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ramco Insulation, Inc.; Super-Stik.
b. <**Insert manufacturer's name; product name or designation**>.
c. or approved equal.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Subject to compliance with requirements, **provide one of the following**:

a. Ramco Insulation, Inc.; Thermokote V.
b. <**Insert manufacturer's name; product name or designation**>.
c. or approved equal.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.
b. <**Insert manufacturer's name; product name or designation**>.
c. or approved equal.

2.3 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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

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-97.
b. Eagle Bridges - Marathon Industries; 290.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
d. Mon-Eco Industries, Inc.; 22-30.
e. Vimasco Corporation; 760.

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f. <**Insert manufacturer's name; product name or designation**>.
g. 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."

C. 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 (minus 73 to plus 93 deg C).

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. <**Insert manufacturer's name; product name or designation**>.
c. 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."

D. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).

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-96.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-33.
c. <**Insert manufacturer's name; product name or designation**>.
d. 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. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

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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. <**Insert manufacturer's name; product name or designation**>.
    f. 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."

F. 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. <**Insert manufacturer's name; product name or designation**>.
    f. 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."

G. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).

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-96.
    b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60.
    c. <**Insert manufacturer's name; product name or designation**>.
    d. or approved equal.

H. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C,

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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. <**Insert manufacturer's name; product name or designation**>.
    f. 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."

I. 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. <**Insert manufacturer's name; product name or designation**>.
    f. 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."

2.4 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:

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a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.
c. <**Insert manufacturer's name; product name or designation**>.
d. or approved equal.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
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. <**Insert manufacturer's name; product name or designation**>.
f. or approved equal.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
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. <**Insert manufacturer's name; product name or designation**>.
e. or approved equal.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).

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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. <**Insert manufacturer's name; product name or designation**>.
   g. or approved equal.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 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. <**Insert manufacturer's name; product name or designation**>.
   e. 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 (Minus 18 to plus 82 deg C).
5. Color: White.

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2.6 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. <**Insert manufacturer's name; product name or designation**>.
    g. 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. <**Insert manufacturer's name; product name or designation**>.
    f. 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 (Minus 73 to plus 149 deg C).
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.

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d. Mon-Eco Industries, Inc.; 44-05.
e. <**Insert manufacturer's name; product name or designation**>.
f. 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 (Minus 40 to plus 121 deg C).
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. <**Insert manufacturer's name; product name or designation**>.
c. 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 (Minus 40 to plus 121 deg C).
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."

2.7 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;

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complying with ASTM C 1136, Type II.

5. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric 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) <**Insert manufacturer's name; product name or designation**>.
        3) or approved equal.

6. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric 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) <**Insert manufacturer's name; product name or designation**>.
        3) 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) <**Insert manufacturer's name; product name or designation**>.
        3) or approved equal.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

    1. Products: Subject to compliance with requirements, provide one of the following:

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a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.
b. <**Insert manufacturer's name; product name or designation**>.
c. or approved equal.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), 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. <**Insert manufacturer's name; product name or designation**>.
d. or approved equal.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

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. <**Insert manufacturer's name; product name or designation**>.
c. or approved equal.

2.10 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. <**Insert manufacturer's name; product name or designation**>.
f. or approved equal.

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2. Adhesive: As recommended by jacket material manufacturer.
3. Color: [**White**] [**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. <**Insert manufacturer's name; product name or designation**>.
    e. or approved equal.

2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. [**Sheet and roll stock ready for shop or field sizing**] [**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- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**] [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil- (0.063-mm-) thick polysurlyn**].
    d. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil- (0.063-mm-) 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.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

    a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and**

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rolled to size].

b. Material, finish, and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: [**1-mil-** (0.025-mm-) **thick, heat-bonded polyethylene and kraft paper**] [**3-mil-** (0.075-mm-) **thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-** (0.063-mm-) **thick polysurlyn**].

d. Moisture Barrier for Outdoor Applications: [**3-mil-** (0.075-mm-) **thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-** (0.063-mm-) **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.

E. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) 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. <**Insert manufacturer's name; product name or designation**>.
d. or approved equal.

F. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with [**white**] [**stucco-embossed**] aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Polyguard Products, Inc.; Alumaguard 60.
b. <**Insert manufacturer's name; product name or designation**>.
c. or approved equal.

G. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric 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.

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1. Products: Subject to compliance with requirements, provide one of the following:

    a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film.
    b. <**Insert manufacturer's name; product name or designation**>.
    c. or approved equal.

H. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) 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.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Dow Chemical Company (The); Saran 560 Vapor Retarder Film.
    b. <**Insert manufacturer's name; product name or designation**>.
    c. or approved equal.

I. 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. <**Insert manufacturer's name; product name or designation**>.
    c. or approved equal.

2.11 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. <**Insert manufacturer's name; product name or designation**>.
    f. or approved equal.

2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) 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.

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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. <**Insert manufacturer's name; product name or designation**>.
    f. or approved equal.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) 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. <**Insert manufacturer's name; product name or designation**>.
    e. or approved equal.

2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) 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. <**Insert manufacturer's name; product name or designation**>.
    f. or approved equal.

2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

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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. <**Insert manufacturer's name; product name or designation**>.
   c. or approved equal.

2. Width: 3 inches (75 mm).
3. Film Thickness: 4 mils (0.10 mm).
4. Adhesive Thickness: 1.5 mils (0.04 mm).
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

F. PVDC Tape for Outdoor 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 560 Vapor Retarder Tape.
   b. <**Insert manufacturer's name; product name or designation**>.
   c. or approved equal.

2. Width: 3 inches (75 mm).
3. Film Thickness: 6 mils (0.15 mm).
4. Adhesive Thickness: 1.5 mils (0.04 mm).
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.12 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. <**Insert manufacturer's name; product name or designation**>.
   d. or approved equal.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, [**Type 304**] [**or**] [**Type 316**]; 0.015 inch (0.38 mm) thick, [**1/2 inch (13 mm)**] [**3/4 inch (19 mm)**] wide with [**wing seal**] [**or**] [**closed seal**].
3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, [**1/2 inch (13 mm)**] [**3/4 inch (19 mm)**] 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.

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B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: [**0.080-inch (2.0-mm) nickel-copper alloy**] [**0.062-inch (1.6-mm) soft-annealed, stainless steel**] [**0.062-inch (1.6-mm) soft-annealed, galvanized steel**].

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. C & F Wire.
b. <**Insert manufacturer's name**>.
c. 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 (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). 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 (0 and 149 deg C) with an epoxy coating. Consult coating

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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.

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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.

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- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Longitudinal seams: Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). 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 (50 mm)**] [**4 inches (100 mm)**] 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 (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

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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 (50 mm) 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 (50 mm).
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.

1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

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2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

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

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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 centerline 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 (50 mm) 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 (300-mm) intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) 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 (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

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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.

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 insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.8 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 (150 mm) 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

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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 (25 mm), 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.

3.9 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

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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.

3.10 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 (150 mm) 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 (25 mm), 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.

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3.11 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

B. 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 (150 mm) o.c.
4. For insulation with factory-applied jackets with vapor retarders 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.

C. 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.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
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.

3.12 INSTALLATION OF POLYISOCYANURATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

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, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of polyisocyanurate 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.

3.13 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube 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 polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended

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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 polyolefin 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 cut sections of polyolefin pipe and sheet 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.
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.

3.14 INSTALLATION OF POLYSTYRENE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

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, and make thickness same as adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm).
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

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D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed section of polystyrene 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.

3.15 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 (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) 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 (38-mm) laps at longitudinal seams and 3-inch-

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(75-mm-) 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 (25-mm) 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 (50-mm) 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 (300 mm) 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 (50 mm) 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 (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) 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.

3.16 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

1. Flat Acrylic Finish: [**Two**] <**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

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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.

3.17 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**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**] <**Insert number**> locations of straight pipe, [**three**] <**Insert number**> locations of threaded fittings, [**three**] <**Insert number**> locations of welded fittings, [**two**] <**Insert number**> locations of threaded strainers, [**two**] <**Insert number**> locations of welded strainers, [**three**] <**Insert number**> locations of threaded valves, and [**three**] <**Insert number**> 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.

3.18 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.

3.19 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

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1. All Pipe Sizes: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**1-1/2 inches** (38 mm)] <**Insert dimension**> thick.
    b. Flexible Elastomeric: [**3/4 inch** (19 mm)] [**1 inch** (25 mm)] <**Insert dimension**> thick.
    c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1/2 inch** (13 mm)] [**1 inch** (25 mm)] <**Insert dimension**> thick.
    d. Phenolic: [**1 inch** (25 mm)] <**Insert dimension**> thick.
    e. Polyisocyanurate: [**1 inch** (25 mm)] <**Insert dimension**> thick.
    f. Polyolefin: [**3/4 inch** (19 mm)] [**1 inch** (25 mm)] <**Insert dimension**> thick.

B. Chilled Water and Brine, 40 Deg F (5 Deg C) and below:

1. [**NPS 3** (DN 80)] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.
    b. Mineral-Fiber, [**Preformed Pipe, Type I**] [**or**] [**Pipe Insulation Wicking System**]: [**1 inch** (25 mm)] [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.
    c. Phenolic: [**1 inch** (25 mm)] [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
    d. Polyisocyanurate: [**1 inch** (25 mm)] <**Insert dimension**> thick.

2. [**NPS 4** (DN 100) **to NPS 12** (DN 300)] <**Insert pipe size range**>: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
    b. Mineral-Fiber, [**Preformed Pipe, Type I**] [**or**] [**Pipe Insulation Wicking System**]: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.
    c. Phenolic: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
    d. Polyisocyanurate: [**1 inch** (25 mm)] <**Insert dimension**> thick.

3. [**NPS 14** (DN 350)] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
    b. Mineral-Fiber, [**Preformed Pipe, Type I,**] [**Pipe and Tank Insulation,**] [**or**] [**Pipe Insulation Wicking System**]: [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
    c. Phenolic: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.

C. Chilled Water and Brine, above 40 Deg F (5 Deg C):

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1. [**NPS 12** (DN 300)] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.
    b. Flexible Elastomeric: [**1 inch** (25 mm)] <**Insert dimension**> thick.
    c. Mineral-Fiber, [**Preformed Pipe, Type I**] [**or**] [**Pipe Insulation Wicking System**]: [**1 inch** (25 mm)] [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.
    d. Phenolic: [**1 inch** (25 mm)] [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
    e. Polyisocyanurate: [**1 inch** (25 mm)] <**Insert dimension**> thick.
    f. Polyolefin: [**1 inch** (25 mm)] <**Insert dimension**> thick.

2. [**NPS 14** (DN 350)] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
    b. Mineral-Fiber [**Preformed Pipe, Type I,**] [**Pipe and Tank Insulation,**] [**or**] [**Pipe Insulation Wicking System**]: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
    c. Phenolic: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.

D. Condenser-Water Supply and Return:

1. [**NPS 12** (DN 300)] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.
    b. Flexible Elastomeric: [**1 inch** (25 mm)] <**Insert dimension**> thick.
    c. Mineral-Fiber, Preformed Pipe, Type I: [**1 inch** (25 mm)] [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.
    d. Phenolic: [**1 inch** (25 mm)] [**1-1/2 inches** (38 mm)] <**Insert dimension**> thick.
    e. Polyisocyanurate: [**1 inch** (25 mm)] <**Insert dimension**> thick.
    f. Polyolefin: [**1 inch** (25 mm)] <**Insert dimension**> thick.

2. [**NPS 14** (DN 350)] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
    b. Mineral-Fiber, [**Preformed Pipe, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
    c. Phenolic: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.

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E. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and Below:

1. [**NPS 12 (DN 300)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

   a. Cellular Glass: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**] <**Insert dimension**> thick.
   b. Mineral-Fiber, Preformed Pipe, Type I: [**1 inch (25 mm)**] [**2 inches (50 mm)**] <**Insert dimension**> thick.
   c. Phenolic: [**1 inch (25 mm)**] [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick.
   d. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.

2. [**NPS 14 (DN 350)**] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

   a. Cellular Glass: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick.
   b. Mineral-Fiber, [**Preformed Pipe, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick.
   c. Phenolic: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick.

F. Heating-Hot-Water Supply and Return, above 200 Deg F (93 Deg C):

1. [**NPS 3/4 (DN 20)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

   a. Calcium Silicate: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick.
   b. Cellular Glass: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick.
   c. Mineral-Fiber, Preformed Pipe, Type I or II: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**] <**Insert dimension**> thick.

2. [**NPS 1 (DN 25)**] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

   a. Calcium Silicate: [**3 inches (75 mm)**] [**4 inches (100 mm)**] <**Insert dimension**> thick.
   b. Cellular Glass: [**3 inches (75 mm)**] [**4 inches (100 mm)**] <**Insert dimension**> thick.
   c. Mineral-Fiber, Preformed Pipe, Type I or II: [**3 inches (75 mm)**] [**4 inches (100 mm)**] <**Insert dimension**> thick.

G. Steam and Steam Condensate, 350 Deg F (177 Deg C) and Below:

1. [**NPS 3/4 (DN 20)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

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a. Calcium Silicate: [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
b. Cellular Glass: [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
c. Mineral-Fiber, Preformed Pipe, Type I or II: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.

2. [**NPS 1** (DN 25)] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

a. Calcium Silicate: [**3 inches** (75 mm)] [**4 inches** (100 mm)] <**Insert dimension**> thick.
b. Cellular Glass: [**3 inches** (75 mm)] [**4 inches** (100 mm)] <**Insert dimension**> thick.
c. Mineral-Fiber, [**Preformed Pipe, Type I or II**] [**or**] [**Pipe and Tank Insulation**]: [**3 inches** (75 mm)] [**4 inches** (100 mm)] <**Insert dimension**> thick.

H. Steam and Steam Condensate, above 350 Deg F (177 Deg C):

1. [**NPS 3/4** (DN 20)] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

a. Calcium Silicate: [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
b. Cellular Glass: [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
c. Mineral-Fiber, Preformed Pipe, Type I or II: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.

2. [**NPS 1** (DN 25)] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

a. Calcium Silicate: [**3 inches** (75 mm)] [**4 inches** (100 mm)] <**Insert dimension**> thick.
b. Cellular Glass: [**3 inches** (75 mm)] [**4 inches** (100 mm)] <**Insert dimension**> thick.
c. Mineral-Fiber, [**Preformed Pipe, Type I or II**] [**or**] [**Pipe and Tank Insulation**]: [**3 inches** (75 mm)] [**4 inches** (100 mm)] <**Insert dimension**> thick.

I. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

a. Cellular Glass: [**1-1/2 inches** (38 mm)] <**Insert dimension**> thick.
b. Flexible Elastomeric: [**1 inch** (25 mm)] <**Insert dimension**> thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1 inch** (25 mm)] <**Insert dimension**> thick.
d. Phenolic: [**1 inch** (25 mm)] <**Insert dimension**> thick.

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e. Polyisocyanurate: [**1 inch** (25 mm)] <**Insert dimension**> thick.
f. Polyolefin: [**1 inch** (25 mm)] <**Insert dimension**> thick.

J. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

a. Flexible Elastomeric: [**1 inch** (25 mm)] <**Insert dimension**> thick.
b. Polyolefin: [**1 inch** (25 mm)] <**Insert dimension**> thick.

K. Dual-Service Heating and Cooling, 40 to 200 Deg F (5 to 93 Deg C):

1. [**NPS 12** (DN 300)] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

a. Cellular Glass: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.
b. Mineral-Fiber, Preformed Pipe, Type I: [**1 inch** (25 mm)] [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] <**Insert dimension**> thick.
c. Phenolic: [**1 inch** (25 mm)] [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
d. Polyisocyanurate: [**1 inch** (25 mm)] <**Insert dimension**> thick.

2. [**NPS 14** (DN 350)] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

a. Cellular Glass: [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
b. Mineral-Fiber, [**Preformed Pipe, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.
c. Phenolic: [**1-1/2 inches** (38 mm)] [**2 inches** (50 mm)] [**3 inches** (75 mm)] <**Insert dimension**> thick.

L. Heat-Recovery Piping:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

a. Cellular Glass: [**1-1/2 inches** (38 mm)] <**Insert dimension**> thick.
b. Flexible Elastomeric: [**1 inch** (25 mm)] <**Insert dimension**> thick.
c. Mineral-Fiber, [**Preformed Pipe Insulation, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**1 inch** (25 mm)] <**Insert dimension**> thick.
d. Phenolic: [**1 inch** (25 mm)] <**Insert dimension**> thick.
e. Polyisocyanurate: [**1 inch** (25 mm)] <**Insert dimension**> thick.
f. Polyolefin: [**1 inch** (25 mm)] <**Insert dimension**> thick.

3.20 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine:

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1. All Pipe Sizes: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**3 inches** (75 mm)] <**Insert dimension**> thick.
    b. Flexible Elastomeric: [**3 inches** (75 mm)] <**Insert dimension**> thick.
    c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**3 inches** (75 mm)] <**Insert dimension**> thick.
    d. Phenolic: [**2 inches** (50 mm)] <**Insert dimension**> thick.
    e. Polyisocyanurate: [**2 inches** (50 mm)] <**Insert dimension**> thick.
    f. Polyolefin: [**3 inches** (75 mm)] <**Insert dimension**> thick.
    g. Polystyrene: [**2 inches** (50 mm)] <**Insert dimension**> thick.

B. Condenser-Water Supply and Return:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**2 inches** (50 mm)] <**Insert dimension**> thick.
    b. Flexible Elastomeric: [**2 inches** (50 mm)] <**Insert dimension**> thick.
    c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches** (50 mm)] <**Insert dimension**> thick.
    d. Phenolic: [**2 inches** (50 mm)] <**Insert dimension**> thick.
    e. Polyisocyanurate: [**2 inches** (50 mm)] <**Insert dimension**> thick.
    f. Polyolefin: [**2 inches** (50 mm)] <**Insert dimension**> thick.
    g. Polystyrene: [**2 inches** (50 mm)] <**Insert dimension**> thick.

C. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and Below:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

    a. Cellular Glass: [**3 inches** (75 mm)] <**Insert dimension**> thick.
    b. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches** (50 mm)] <**Insert dimension**> thick.
    c. Phenolic: [**2 inches** (50 mm)] <**Insert dimension**> thick.
    d. Polyisocyanurate: [**2 inches** (50 mm)] <**Insert dimension**> thick.

D. Heating-Hot-Water Supply and Return, above 200 Deg F (93 Deg C):

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

    a. Calcium Silicate: [**3 inches** (75 mm)] <**Insert dimension**> thick.
    b. Cellular Glass: [**3 inches** (75 mm)] <**Insert dimension**> thick.
    c. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: [**2 inches** (50 mm)] <**Insert dimension**> thick.

E. Steam and Steam Condensate, 350 Deg F (177 Deg C) and Below:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

    a. Calcium Silicate: [**4 inches** (100 mm)] <**Insert dimension**> thick.
    b. Cellular Glass: [**4 inches** (100 mm)] <**Insert dimension**> thick.
    c. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: [**3 inches** (75 mm)]

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<**Insert dimension**> thick.

F. Steam and Steam Condensate, above 350 Deg F (177 Deg C):

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

   a. Calcium Silicate: [**5 inches** (125 mm)] <**Insert dimension**> thick.
   b. Cellular Glass: [**5 inches** (125 mm)] <**Insert dimension**> thick.
   c. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: [**4 inches** (100 mm)] <**Insert dimension**> thick.

G. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

   a. Cellular Glass: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   b. Flexible Elastomeric: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   d. Phenolic: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   e. Polyisocyanurate: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   f. Polyolefin: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   g. Polystyrene: [**2 inches** (50 mm)] <**Insert dimension**> thick.

H. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

   a. Flexible Elastomeric: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   b. Polyolefin: [**2 inches** (50 mm)] <**Insert dimension**> thick.

I. Heat-Recovery Piping:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

   a. Cellular Glass: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   b. Flexible Elastomeric: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   c. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   d. Phenolic: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   e. Polyisocyanurate: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   f. Polyolefin: [**2 inches** (50 mm)] <**Insert dimension**> thick.
   g. Polystyrene: [**2 inches** (50 mm)] <**Insert dimension**> thick.

J. Dual-Service Heating and Cooling:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

   a. Cellular Glass: [**3 inches** (75 mm)] <**Insert dimension**> thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches** (50 mm)] <**Insert dimension**> thick.

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c. Phenolic: [**2 inches** (50 mm)] <**Insert dimension**> thick.
d. Polyisocyanurate: [**2 inches** (50 mm)] <**Insert dimension**> thick.

K. Fuel Oil Piping, Heated:

1. All Pipe Sizes: Insulation shall be[**one of**] the following:

a. Cellular Glass: [**2 inches** (50 mm)] <**Insert dimension**> thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches** (50 mm)] <**Insert dimension**> thick.

3.21 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Section 232113.13 "Underground Hydronic Piping" and Section 336313 "Underground Steam and Condensate Distribution Piping."

B. Chilled Water, All Sizes: Cellular glass, [**2 inches** (50 mm)] <**Insert dimension**> thick.

C. Condenser-Water Supply and Return, All Sizes: Cellular glass, [**2 inches** (50 mm)] <**Insert dimension**> thick.

D. Heating-Hot-Water Supply and Return, All Sizes, 200 Deg F (93 Deg C) and Below: Cellular glass, [**3 inches** (75 mm)] <**Insert dimension**> thick.

E. Heating-Hot-Water Supply and Return, All Sizes, above 200 Deg F (93 Deg C):

1. Calcium Silicate: [**3 inches** (75 mm)] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches** (75 mm)] <**Insert dimension**> thick.

F. Steam and Steam Condensate, All Sizes, 350 Deg F (177 Deg C) and Below:

1. Calcium Silicate: [**4 inches** (100 mm)] <**Insert dimension**> thick.
2. Cellular Glass: [**4 inches** (100 mm)] <**Insert dimension**> thick.

G. Steam and Steam Condensate, All Sizes, above 350 Deg F (177 Deg C):

1. Calcium Silicate: [**5 inches** (125 mm)] <**Insert dimension**> thick.
2. Cellular Glass: [**5 inches** (125 mm)] <**Insert dimension**> thick.

H. Dual-Service Heating and Cooling, All Sizes, 40 to 200 Deg F (4 to 93 Deg C): Cellular glass, [**3 inches** (75 mm)] <**Insert dimension**> thick.

I. Fuel Oil Piping, All Sizes, Heated: Cellular glass, [**2 inches** (50 mm)] <**Insert dimension**> thick.

3.22 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install

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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.
2. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils** (0.5 mm)] [**30 mils** (0.8 mm)] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch** (0.41 mm)] [**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] [**0.032 inch** (0.81 mm)] [**0.040 inch** (1.0 mm)] thick.
4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch** (0.41 mm)] [**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] [**0.032 inch** (0.81 mm)] thick.
5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch** (0.25 mm)] [**0.016 inch** (0.41 mm)] [**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] thick.
6. <**Insert jacket type**>.

D. Piping, Exposed:

1. None.
2. [**PVC**] [PVC, Color-Coded by System]: [**20 mils** (0.5 mm)] [**30 mils** (0.8 mm)] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch** (0.41 mm)] [**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] [**0.032 inch** (0.81 mm)] [**0.040 inch** (1.0 mm)] thick.
4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch** (0.41 mm)] [**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] [**0.032 inch** (0.81 mm)] thick.
5. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch** (0.25 mm)] [**0.016 inch** (0.41 mm)] [**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] thick.
6. <**Insert jacket type**>.

3.23 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. None.
2. [**PVC**] [**PVC**, Color-Coded by System]: [**20 mils** (0.5 mm)] [**30 mils** (0.8 mm)] thick.
3. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch** (0.41 mm)]

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[**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] [**0.032 inch** (0.81 mm)] [**0.040 inch** (1.0 mm)] thick.

4. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch** (0.41 mm)] [**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] [**0.032 inch** (0.81 mm)] thick.
5. Stainless Steel, Type [**304**] [**316**] [**304 or 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch** (0.25 mm)] [**0.016 inch** (0.41 mm)] [**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] thick.
6. <**Insert jacket type**>.

D. Piping, Exposed:

1. PVC: [**20 mils** (0.5 mm)] [**30 mils** (0.8 mm)] [**40 mils** (1.0 mm)] thick.
2. [**Pai**nted]Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.016 inch** (0.41 mm)] [**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] [**0.032 inch** (0.81 mm)] [**0.040 inch** (1.0 mm)] thick.
3. Stainless Steel, Type [**304**] [**316**] [**304 or 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.010 inch** (0.25 mm)] [**0.016 inch** (0.41 mm)] [**0.020 inch** (0.51 mm)] [**0.024 inch** (0.61 mm)] thick.
4. <**Insert jacket type**>.

3.24 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

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 230719

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SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. The purpose of this effort is to bring the project mechanical systems to a state of dynamic operation in accordance with the contract documents by verifying the operation of individual components, subsystems and systems.

C. The Owner will retain the services of an independent commissioning agent (CA) separate from the work of this Contract. As herein specified the DEN Project Manager and CA shall develop detailed commissioning procedures, equipment checkout procedures and data forms for recording compliance with contract documents, performance and punch list deficiencies, and will assist in developing schedules for checkout and Owner acceptance, at a future date during the construction phase.

D. The Division 23 Mechanical Contractor and the General Contractor shall include as part of the Work of this Contract, labor and material to provide manpower, equipment, tools, ladders, instruments, etc., necessary to accomplish the work and labor and material for execution, monitoring and printing data forms necessary to verify and record system observations.

E. The Test and Balance Contractors shall include as part of the work of this contract, labor, and material to provide manpower, equipment, tools, ladders, instruments, etc. necessary to execute and accomplish the work.

F. At the completion of the start-up, operations performance test and test and balance, the Contractor shall conduct a 72-hour dynamic mode demonstration of the systems in the presence of the DEN Project Manager and CA.

G. Related Sections:

1. Section 019113 "General Commissioning Requirements" for general commissioning process requirements.

H. Commissioned Equipment:

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1. Fan Coil Units.
2. Modular Chillers
3. Heat excahngers
4. Glycol pumps, and components.
5. Building heating water pumps and components.
6. Building chilled water pumps and components.

I. Commissioned Systems:

1. Modular chillers.
2. Glycol pumps.
3. Heat exchanges.
4. Pumps.

1.3 DEFINITIONS

A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CA: Commissioning Authority.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

1.5 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Section 012100 "Allowances."

1.6 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Section 012200 "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

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1.7 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CA.

E. Provide information requested by the CA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.8 COMMISSIONING AGENT'S REQUIREMENTS AND RESPONSIBILITIES

A. This Article covers the Scope of Work for the Commissioning Agent (CA) who will be hired by the Owner.

B. Description of the Work:

1. The Commissioning Agent shall oversee the commissioning of the HVAC systems as described in this Section. The CA shall prepare pre-commissioning and functional performance test checklists to be used by the Contractor. Prepare and publish a commissioning plan. Witness startup and operational tests of equipment and systems. Perform observations of the mechanical systems throughout construction and prepare the final commissioning document.
2. The CA shall have authority to direct and schedule testing. The CA shall have no authority to direct changes to the systems.

C. Commissioning Plan:

1. The CA shall prepare a plan listing the parties involved with their responsibility, scope, definitions, safety concerns, design criteria, attendance schedules, commissioning schedules, and commissioning manual requirements.

D. Commissioning Forms:

1. Review 100% of CDs. Provide written summary of how each commissioned item of equipment should operate; include calculations verifying scheduled capacity.
2. The CA shall develop forms similar to that in this Section for the Contractors use during the commissioning process. The forms shall become part of the final commissioning manual. Forms shall be provided for each piece of commissioned equipment and system. Any deviations from the design shall be noted and approved by the DEN Project Manager prior to acceptance. Each form shall be signed by the Contractor, CA, and DEN Project Manager prior to acceptance of a system or piece of equipment.

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E. Commissioned Equipment:

1. All chiller modules as scheduled.
2. All pumps as scheduled.
3. All heat exchangers as scheduled.
4. All fan coil units as scheduled.

F. Commissioned Systems:

1. All HVAC systems including the glycol system.

G. Project Observations:

1. The CA shall perform observations of construction progress for the equipment and systems to be commissioned twice a month at a minimum and more as required to keep pace with construction. The CA shall note progress and any deviations of the construction documents shall be brought to attention of the Contractor and DEN Project Manager for resolution. The CA will have no authority to direct changes or corrections to the system. Observation reports shall be published to the DEN Project Manager and Contractor and shall be part of the final commissioning manual.

H. Operational and Start-Up Tests:

1. The CA shall witness start-up tests and collect documentation of the tests. The CA shall notify the DEN Project Manager and Contractor of any deviations from the contract documents. Any deviations shall be corrected or accepted by the DEN Project Manager prior to acceptance.
2. After the Contractor has submitted in writing that the systems are completed, the CA shall schedule and direct operational tests of the systems. These tests shall be as described in this Section. The results shall be documented and made part of the commissioning manual. Any deviations from the design shall be brought to the attention of the DEN Project Manager and Contractor. Any deviations shall be corrected or accepted by the DEN Project Manager prior to acceptance.

I. Commissioning Manual:

1. The CA shall prepare the final commissioning manual. The manual shall provide a complete history of the commissioning process and shall include:

    a. Design and Energy Codes.
    b. Commissioning Plan.
    c. Completed Commissioning Forms.
    d. Completed Observation Reports.
    e. Completed Start-up Reports.
    f. System Operational Tests.
    g. Final sequence of operation to be achieved.
    h. Summary of building operation as commissioned, noting deviations from design.
    i. Design Criteria (extended from Design Documents by CA).

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j. Written summary of normal startup and operating procedures for each commissioned item of equipment.
k. The manual shall be a three ring binder with tabs for each section. Provide five (5) copies.

1.9 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
6. Test and inspection reports and certificates.
7. Corrective action documents.
8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS

2.1 MATERIALS, LABOR, INSTRUMENTS, TOOLS, LADDERS AND APPARATUS

A. The Contractor shall provide all materials, labor, instruments, tools, ladders, and apparatus necessary to start-up, perform operating performance test and systems conditioning.

B. The Contractor shall be responsible for maintaining the commissioning documentation until final acceptance of the Project. The checklists in appendix one are samples for bidding purposes. Final checklists will be produced by the CA and provided prior to beginning commissioning. The commissioning documentation shall be kept current by the Contractor and shall be available for inspection at all times. At the time of acceptance of the Project, the Contractor shall surrender three (3) completed copies of the commissioning documentation to the DEN Project Manager.

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Before request for contract compliance inspection and system commissioning all equipment, components, and systems shall be started-up, adjusted, calibrated; set,

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test and check all electric disconnect, fuses, circuit breakers, valves, dampers, temperatures and pressures of all systems for proper operation and performance. After completion of the start-up and operating performance test, the Contractor will notify the Owner in writing that the system is ready for commissioning.

B. Information, date, etc. from start-up and operating performance test may be utilized, as appropriate, to execute preliminary commissioning documentation, however, certification of equipment and systems for the preliminary commissioning phase shall be completed in accordance with the following Article of this section of the specifications.

1. Start-up and operating performance test documentation shall include the following:

a. Fan Coil Unit Systems:

1) Coil entering and leaving air temperature.
2) Space temperatures at thermostats or sensors.
3) Total fan air CFM.
4) Fan speed.
5) Fan total static pressure.

b. Electric Motors:

1) Full load amperes and voltage.
2) Starter heater size and rated amperage range for heater installed.
3) Measure running current, after adjustment of system to deliver rated performance.

c. Controls:

1) Operational setting of controllers and instruments.
2) Positioning and function of valves and dampers.
3) Interlock and operation of systems (HVAC).

d. Modular Chiller System:

1) Compressor safety and operating controls.
2) Capacity reduction and staging controls.

C. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

D. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

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E. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

F. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

G. Inspect and verify the position of each device and interlock identified on checklists.

H. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

I. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CA.

B. Notify the CA at least 10 days in advance of testing and balancing Work, and provide access for the CA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CA.

1. The CA will notify testing and balancing Contractor10 days in advance of the date of field verification. Notice will not include data points to be verified.
2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CA so verification of failed portions can be performed.

3.3 SYSTEM COMMISSIONING

A. All systems, components, equipment, etc., furnished as part of this Contract shall be subjected to system commissioning as hereinafter specified. All systems, components, equipment, etc., commissioned In this section of the Specifications shall be evaluated based on the sequences of control/operation, performance characteristics, and equipment schedules, etc., as specified in other sections of the Specifications and as shown on the Contract drawings. Systems, components, equipment, etc., that do not have specified operating sequence, etc., shall be operated and evaluated based on their use and function for this project.

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B. Commissioning Documentation: The Contractor shall maintain the commissioning documentation in 3-ring binders. The commissioning documentation shall be organized by system when practicable. All pages shall be numbered and a table of contents page shall be provided. The commissioning documentation shall include, but not be limited to, the following:

1. Design Criteria provided by the A/E.
2. Approved Test and Balance Report for the system or component being commissioned, provided by Test and Balance Contractor.
3. Approved submittals for all equipment to be commissioned, provided by Mechanical Contractor.
4. All approved shop drawings of equipment to be commissioned. Shop drawings shall be full size sheets folded as required to fit in binders. Provided by Mechanical Contractor.
5. All pre-commissioning checklists initialized by indicated personnel organized by system and subsystem.
6. All functional performance test checklist initialized by indicated personnel organized by systems and subsystems.
7. Three copies of the Operation and Maintenance Manuals specified in other sections of these specifications shall be reviewed by the CA for completeness and for applicability. The manuals shall be incorporated in the Commissioning Documentation prior to the commencement of the training required in other sections of the specifications. Preparation of Operation and Maintenance Manuals shall be as specified in other sections of these specifications.

C. Shop Drawings and As-Built Drawings and Specifications shall be assembled by the Contractor after completion of the pre-commissioning phase and turned over to the DEN Project Manager. Changes as a result of subsequent Commissioning procedures will be incorporated (as required) at the conclusion of final Commissioning.

D. Commissioning Schedule:

1. Phase 1 - Preliminary Commissioning: All shop drawings, including but not limited to, equipment, controls, test and balance reports, and operation and maintenance manuals, shall be submitted and approved by the CA. In addition, all pre-commissioning checklists shall be completed and initialed by all parties.
2. Phase 2 - Functional Performance Testing: Functional Performance Testing shall be performed as indicated on the Functional Performance Test Checklists. Functional Performance Testing shall not begin until Phase 1 of the commissioning process is complete. Owner's operation and maintenance personnel shall observe the function performance testing. The Contractor may perform initial system familiarization and training of Owner's operating and maintenance personnel required under other sections of the Specification during the functional performance testing.
3. Functional Performance Test Notification: The Contractor shall notify the CA two (2) weeks before functional performance testing is to begin.
4. Phase 3 - System training and operating instructions shall be conducted by the Contractor as indicated in the specifications of each item of equipment. The Contractor shall be responsible for specified training and operating instructions being observed by the CA

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E. Pre-Commissioning Checklists:

1. Pre-Commissioning Checklists shall be developed by the CA and shall be executed and certified prior to the commencement of functional performance testing. The indicated initial is required in each location for all items, except where an "X" is shown indicating an initial is not required. See initials legend below for required initials. The pre-commissioning checklist will not be accepted as complete until all items have been initialed signifying this portion of the project is ready for Functional Performance Testing. The Contractor shall provide the CA with the completed Pre-Commissioning Checklists for his review and initials. The CA shall be the last person to initial each checklist item. The Contractor shall submit for approval a list of all contractor and subcontractor representatives responsible for the completion of the pre-commissioning checklist phase of the project. This list of representatives shall be submitted two (2) weeks prior to commencement of any pre-commissioning activities of any systems or equipment. Representatives may be replaced only after written approval from the CA.
2. Initials Legend:

    a. Construction Manager.
    b. Mechanical Contractor's representative.
    c. Electrical Contractor' s representative.
    d. Commissioning Agent.
    e. Balancing Contractor's representative.
    f. Controls Contractor's representative.

3. Blank Example Pre-Commissioning Checklists are in Appendix, located at the end of this Section of the specifications. A separate Pre-Commissioning checklist shall be provided for each system and piece of HVAC equipment to be Commissioned.

F. Functional Performance Test Checklist:

1. Functional performance testing shall be performed by the Contractor as directed by the CA and observed by a commissioning team consisting of the individuals indicated on the Functional Performance Test Checklists. The Contractor shall submit in writing a list of all contractor and subcontractor representatives responsible for the functional performance testing phase of the project. This list of representatives shall be submitted two (2) weeks prior to the commencement of functional performance testing of systems and equipment. All representatives shall remain on the commissioning team throughout functional performance testing. Substitutions will not be permitted. Functional performance test checklists shall be completed in the presence of all commissioning team personnel at the time of the functional performance test.
2. Upon failure of completion of a functional performance test checklist, the Contractor shall provide a written report to the CA listing the deficiencies causing the failure and remedies to correct all deficiencies. After the Contractor has corrected all deficiencies, the entire functional performance test checklist for the item of equipment shall be repeated. If possible, corrections can be accomplished during the functional performance testing of equipment in other

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non-related systems. In any case, no system will be accepted until all equipment items in the system have complete functional performance test checklists thereby demonstrating satisfactory performance.

3. Failure to complete 2 functional performance test checklists constitutes failure of Phase 2 of the HVAC Commissioning process. The Contractor shall provide a written report to the CA listing the deficiencies causing all failures and remedies to correct all deficiencies. After correction of all deficiencies, Phase 2 of the HVAC Commissioning process shall be repeated in its entirety. The Contractor shall give the CA two (2) weeks notice before repeat functional performance testing is scheduled. Should the first or one subsequent functional performance test fail, the Owner reserves the right to obtain compensation from the Contractor for fees and expenses incurred in conjunction with having to perform more than two (2) functional performance tests.
4. Blank examples functional performance test checklists are in the Appendix 2 located at the end of this section of the specifications. A separate Functional Performance Checklist shall be provided for each system and piece of equipment to be Commissioned.

3.4 DEMONSTRATION TEST

A. After completion of system start-up, operating performance test and commissioning, but before Owner acceptance, the Contractor shall conduct a 72 hour dynamic mode demonstration of the systems provided under this Contract. The intent of the 72 hour dynamic test is to verify that the mechanical and electrical equipment will respond as designed to meet the changes that may occur under varying indoor/outdoor conditions including seasonal variations and occupancy loads.

B. A detailed procedure and sequence of events shall be developed by the Contractor and submitted to the Owner and CA for review and approval. Procedures and sequence of events should contain as a minimum the following activities:

1. Hours 1-4: Bring all systems on line for standard operations and parameters.
2. Hours 5-28: Operate all systems under normal parameters and verify proper operation.
3. Hours 29-52: Validation of systems operation through indoor/outdoor changes to include heating, cooling, ventilation, humidity control, domestic and control systems.
4. Hours 69-72: Return of systems to normal operation.

C. Systems and their associated equipment which are to be included in the dynamic test are all systems and components furnished under this Contract and as a minimum will include, but are not limited to the following:
1. Chilled Water Systems.
2. Domestic Water Systems.
3. Fan Coil Systems.
4. Pumping Systems.
5. Building Management and Control Systems.

D. Contractor shall notify the Owner and CA in writing that the Project is completed and

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ready for the demonstration test. Schedule for test will then be established and documented. Initiation of the 72 hours dynamic test will not occur until all systems are balanced, operational, and incorporated into the building management and control system. Should the demonstration test fail for any reason, the problems shall be corrected and another demonstration test conducted. Should the first or one subsequent demonstration test fail, the Owner reserves the right to obtain compensation from the Contractor for fees and expenses incurred in conjunction with having to witness more than two (2) 72 hour demonstration tests.

E. The attendees of each 72 hour demonstration test shall include representative from the following organizations:

1. General Contractor.
2. Mechanical Contractor.
3. Electrical Contractor.
4. Test and Balance Contractor.
5. Building Management and Control System Contractor.
6. DEN Project Manager of Record.
7. Mechanical Engineer.
8. Electrical Engineer.
9. Commissioning Agent.

F. Minor problems are anticipated and the necessary personnel required to correct problems and adjust systems need to be available to insure continuation of the dynamic testing process. If major problems are encountered, at the discretion of the Owner and CA, the testing will be terminated and rescheduled.

G. The Contractor shall notify any external organizations, which would include but not be limited to Fire Department which are not directly involved in the testing, but might be affected due to interface to insure that alarms do not occur.

H. During the demonstration test, all systems shall operate in the "hands-off" automatic mode in accordance with the requirements of the Contract Documents. Changes in operating modes required to simulate load shifting, seasonal changeover, emergency modes, etc., will be accomplished by changing set points and equipment operating status at the BMS central control console as required to observe capacity control and monitoring. Provide a readout of space temperature at each thermostat building relative humidity, building pressurization, chilled water supply and return temperatures and chiller capacity.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

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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 230800

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SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. DDC system for monitoring and controlling of HVAC systems.
2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

B. Related Requirements:

1. Section 230923.13 "Energy Meters" for thermal and electric power energy meters that connect to DDC systems.
2. Section 230923.17 "Level Instruments" for liquid-level switches, sensors, and transmitters that connect to DDC systems.
3. Section 230923.22 "Position Instruments" for limit switches that connect to DDC systems.
4. Section 230993 "Sequence of Operations for HVAC Controls" for control sequences in DDC systems.

1.3 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.

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3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

D. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.

J. DOCSIS: Data-OverCable Service Interface Specifications.

K. E/P: Voltage to pneumatic.

L. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

M. HLC: Heavy load conditions.

N. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

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O. I/P: Current to pneumatic.

P. LAN: Local area network.

Q. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

R. Modbus TCP/IP: An open protocol for exchange of process data.

S. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

T. MTBF: Mean time between failures.

U. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

V. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

W. PDA: Personal digital assistant.

X. Peer to Peer: Networking architecture that treats all network stations as equal partners.

Y. POT: Portable operator's terminal.

Z. PUE: Performance usage effectiveness.

AA. RAM: Random access memory.

BB. RF: Radio frequency.

CC. Router: Device connecting two or more networks at network layer.

DD. Server: Computer used to maintain system configuration, historical and programming database.

EE. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

FF. UPS: Uninterruptible power supply.

GG. USB: Universal Serial Bus.

HH. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

II. VAV: Variable air volume.

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JJ. WLED: White light emitting diode.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data: For each type of product include the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
    a. Enclosures.
    b. Electrical power devices.
    c. Accessories.
    d. Instruments.
    e. Control dampers and actuators.
    f. Control valves and actuators.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

C. Software Submittal:

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1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
2. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.
6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
7. Description of operator interface to alphanumeric and graphic programming.
8. Description of each network communication protocol.
9. Description of system database, including all data included in database, database capacity and limitations to expand database.
10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:

1. General Requirements:

    a. Include cover drawing with Project name, location, Owner, Architect, Contractor, and issue date with each Shop Drawings submission.
    b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
    c. Prepare Drawings using CAD.
    d. Drawings Size: Match contract documents.

2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following:

    a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork, and piping.
    b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
    c. Each desktop operator workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.

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d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
e. Network communication cable and raceway routing.
f. Information, drawn to scale, ofcontract documents.
g. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.

6. Schematic drawings for each controlled HVAC system indicating the following:

a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
c. A graphic showing location of control I/O in proper relationship to HVAC system.
d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays, and interface to DDC controllers.
g. Narrative sequence of operation.
h. Graphic sequence of operation, showing all inputs and output logical blocks.

7. Control panel drawings indicating the following:

a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
c. Front, rear, and side elevations and nameplate legend.
d. Unique drawing for each panel.

8. DDC system network riser diagram indicating the following:

a. Each device connected to network with unique identification for each.
b. Interconnection of each different network in DDC system.
c. For each network, indicate communication protocol, speed, and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable type. Indicate raceway type and size for each.
d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

9. DDC system electrical power riser diagram indicating the following:

a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.

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b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
d. Power wiring type and size, race type, and size for each.

10. Monitoring and control signal diagrams indicating the following:

    a. Control signal cable and wiring between controllers and I/O.
    b. Point-to-point schematic wiring diagrams for each product.
    c. Control signal tubing to sensors, switches, and transmitters.
    d. Process signal tubing to sensors, switches, and transmitters.

11. Color graphics indicating the following:

    a. Itemized list of color graphic displays to be provided.
    b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
    c. Intended operator access between related hierarchical display screens.

E. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:

    a. Loss of power.
    b. Loss of network communication signal.
    c. Loss of controller signals to inputs and outpoints.
    d. Operator workstation failure.
    e. Server failure.
    f. Gateway failure.
    g. Network failure
    h. Controller failure.
    i. Instrument failure.
    j. Control damper and valve actuator failure.

4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

F. Delegated-Design Submittal: For DDC system products and installation indicated as being delegated.

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1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
2. Schedule and design calculations for control dampers and actuators.

    a. Flow at Project design and minimum flow conditions.
    b. Face velocity at Project design and minimum airflow conditions.
    c. Pressure drop across damper at Project design and minimum airflow conditions.
    d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
    e. Maximum close-off pressure.
    f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
    g. Torque required at worst case condition for sizing actuator.
    h. Actuator selection indicating torque provided.
    i. Actuator signal to control damper (on, close or modulate).
    j. Actuator position on loss of power.
    k. Actuator position on loss of control signal.

3. Schedule and design calculations for control valves and actuators.

    a. Flow at Project design and minimum flow conditions.
    b. Pressure-differential drop across valve at Project design flow condition.
    c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
    d. Design and minimum control valve coefficient with corresponding valve position.
    e. Maximum close-off pressure.
    f. Leakage flow at maximum system pressure differential.
    g. Torque required at worst case condition for sizing actuator.
    h. Actuator selection indicating torque provided.
    i. Actuator signal to control damper (on, close or modulate).
    j. Actuator position on loss of power.
    k. Actuator position on loss of control signal.

4. Schedule and design calculations for selecting flow instruments.

    a. Instrument flow range.
    b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
    c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
    d. Pressure-differential loss across instrument at Project design flow conditions.
    e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

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1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

    a. Product installation location shown in relationship to room, duct, pipe, and equipment.
    b. Structural members to which products will be attached.
    c. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
    d. Size and location of wall access panels for products installed behind walls and requiring access.

B. Qualification Data:

1. Systems Provider Qualification Data:

    a. Resume of project manager assigned to Project.
    b. Resumes of application engineering staff assigned to Project.
    c. Resumes of installation and programming technicians assigned to Project.
    d. Resumes of service technicians assigned to Project.
    e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
    f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
    g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
    h. Owner contact information for past project including name, phone number, and e-mail address.
    i. Contractor contact information for past project including name, phone number, and e-mail address.
    j. Architect contact information for past project including name, phone number, and e-mail address.

2. Manufacturer's qualification data.
3. Testing agency's qualifications data.

C. Product Certificates:

1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.

D. Product Test Reports: For each product that requires testing to be performed by manufacturer.

E. Source quality-control reports.

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F. Field quality-control reports.

G. Sample Warranty: For manufacturer's warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to:

1) Design and install new points, panels, and other hardware.
2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
o. Owner training materials.

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1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.

1.9 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least five past projects.
4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

    a. Product research and development.
    b. Product and application engineering.
    c. Product manufacturing, testing, and quality control.
    d. Technical support for DDC system installation training, commissioning, and troubleshooting of installations.
    e. Owner operator training.

B. DDC System Provider Qualifications:

1. Authorized representative of, and trained by, DDC system manufacturer.
2. In-place facility located within50 miles of Project.
3. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
4. Demonstrated past experience on five projects of similar complexity, scope and value.
5. Each person assigned to Project shall have demonstrated past experience.
6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.
9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Testing Agency Qualifications: Member company of NETA or an NRTL.

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1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

D. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

    a. Install updates only after receiving Owner's written authorization.

3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.
4. Warranty Period: Two year(s) from date of Substantial Completion.

    a. For Gateway: Two -year parts and labor warranty for each.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Honeywell International Inc.
2. Johnson Controls, Inc.
3. Automated Logic Corporation.

2.2 DDC SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.

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B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WEB ACCESS

A. DDC system shall be Web based.

1. Web-Based Access to DDC System:

a. DDC system software shall be based on server thin-client architecture, designed around open standards of Web technology. DDC system server shall be accessed using a Web browser over DDC system network, using Owner's LAN, and remotely over Internet[**through Owner's LAN**].
b. Intent of thin-client architecture is to provide operators complete access to DDC system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
c. Web access shall be password protected.

2.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional to design DDC system to satisfy requirements indicated.

1. System Performance Objectives:

a. DDC system shall manage HVAC systems.
b. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
c. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
d. DDC system shall operate while unattended by an operator and through operator interaction.
e. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.

B. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. DDC System Speed:

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1. Response Time of Connected I/O:

    a. AI point values connected to DDC system shall be updated at least every two seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    b. BI point values connected to DDC system shall be updated at least every two seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
    c. AO points connected to DDC system shall begin to respond to controller output commands within one second(s). Global commands shall also comply with this requirement.
    d. BO point values connected to DDC system shall respond to controller output commands within one second(s). Global commands shall also comply with this requirement.

2. Display of Connected I/O:

    a. Analog point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
    b. Binary point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
    c. Alarms of analog and digital points connected to DDC system shall be displayed within 15 seconds of activation or change of state.
    d. Graphic display refresh shall update within four seconds.
    e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.

D. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.

E. Future Expandability:

1. DDC system size shall be expandable to an ultimate capacity of at least two times total I/O points indicated.
2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.

F. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Energy:

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a. Thermal: Within 1 percent of reading.
b. Electric Power: Within 1 percent of reading.
c. Requirements indicated on Drawings for meters not supplied by utility.

2. Flow:

a. Air: Within 2 percent of design flow rate.
b. Water: Within 2 percent of design flow rate.

3. Pressure:
a. Water: Within 0.25 percent of instrument [**range**] [**span**].

4. Temperature, Dry Bulb:
a. Chilled Water: Within 0.5 deg F (0.2 deg C).
b. Condenser Water: Within 0.5 deg F (0.2 deg C).
c. Heating Hot Water: Within 0.5 deg F (0.2 deg C).
d. Temperature Difference: Within 0.25 deg F (0.15 deg C).
e. <**Insert system**>.
f. Other Temperatures Not Indicated: Within 0.5 deg F (0.2 deg C).

5. Vibration: Within 10 percent of reading.

G. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:

1. Current:

a. Milliamperes: Nearest 1/100th of a milliampere.
b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.

2. Energy:

a. Electric Power:

1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.

b. Thermal, Rate:

1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh (For watts, nearest watt up to 1000 W; for kilowatts, round to nearest

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kilowatt up to 1000 kW; nearest 10 kW between 1000 and 10,000 kW; nearest 100 kW for above 10,000 kW).

2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons (For watts, nearest watt up to 1000 W; for kilowatts, round to nearest kilowatt up to 1000 kW; nearest 10 kW between 1000 and 10,000 kW; nearest 100 kW for above 10,000 kW).

c. Thermal, Usage:

1) Heating: For Btu, nearest Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu (For watt-hours, nearest watt-hour up to 1000 Wh; for kilowatt-hours, round to nearest kilowatt-hour up to 1000 kWh; nearest 10 kWh between 1000 and 10,000 kWh; nearest 100 kWh for above 10,000 kWh).

2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons (For watt-hours, nearest watt-hour up to 1000 Wh; for kilowatt-hours, round to nearest kilowatt-hour up to 1000 kWh; nearest 10 kWh between 1000 and 10,000 kWh; nearest 100 kWh for above 10,000 kWh).

3. Flow:
   a. Water: Nearest 1/10th gpm through 100 gpm; nearest gpm between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm (Nearest 1/10th of a L/s through 100 L/s; nearest L/s between 100 and 1000 L/s; nearest 10 L/s between 1000 and 10,000 L/s; nearest 100 L/s above 10,000 L/s).

4. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches (Nearest 1/100th of a mm through 10 mm; nearest 1/10th of a mm between 10 and 100 mm; nearest mm above 100 mm).
5. Speed:
   a. Rotation (rpm): Nearest 1 rpm.
6. Pressure:
   a. Water: Nearest 1/10 psig through 100 psig; nearest psig above 100 psig (Nearest kPa through 1000 kPa; nearest 10 kPa above 1000 kPa).

7. Temperature:
   a. Chilled Water: Nearest 1/10th of a degree.
   b. Condenser Water: Nearest 1/10th of a degree.
   c. Heating Hot Water: Nearest degree.

8. Vibration: Nearest 1/10th in/s (Nearest 1/10th mm/s).
9. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.

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H. Control Stability: Control variables indicated within the following limits:

1. Flow:
   a. Water: Within 2 percent of design flow rate.
2. Pressure:
   a. Water: Within 0.25 percent of instrument range.

3. Temperature, Dry Bulb:
   a. Chilled Water: Within 0.5 deg F (0.2 deg C).
   b. Condenser Water: Within 0.5 deg F (0.2 deg C).
   c. Heating Hot Water: Within 0.5 deg F (0.2 deg C).

I. Environmental Conditions for Controllers, Gateways, and Routers:

1. Products shall operate without performance degradation under ambient environmental temperature, pressure, and humidity conditions encountered for installed location.

   a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.

2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
   a. Mechanical Equipment Rooms:

      1) Chiller and Boiler Rooms: Type 12.

J. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

   a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated[**, cooled**] and ventilated as required by instrument and application.

2. Instruments, actuators, and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:

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a. Mechanical Equipment Rooms:

1) Chiller and Boiler Rooms: Type 12.

K. DDC System Reliability:

1. Design, install and configure DDC controllers, gateways, routers, to yield a MTBF of at least 40,000 hours, based on a confidence level of at least 90 percent. MTBF value shall include any failure for any reason to any part of products indicated.
2. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment that are being controlled, operational and under automatic control.
3. Critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated shall be indicated on Drawings.

L. Electric Power Quality:

1. Power-Line Surges:

a. ProtectDDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
b. Do not use fuses for surge protection.
c. Test protection in the normal mode and in the common mode, using the following two waveforms:

1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

a. ProtectDDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:

1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

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M. Backup Power Source:

1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.

N. UPS:

1. DDC system products powered by UPS units shall include the following:
   a. .
   b. Gateways.
   c. DDC controllers.

2. DDC system instruments and actuators powered by UPS units shall include the following:

   a. Instruments associated with the following systems controlled by DDC system:

      1) Chilled water, condenser water and heating water>.

   b. Valves and actuators associated with the following systems controlled by DDC system:

      1) Chilled water, condenser water and heating water

O. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.5 PANEL-MOUNTED, MANUAL OVERRIDE SWITCHES

A. Manual Override of Control Valves:

1. Include panel-mounted, two-position, selector switch for each automatic control valve being controlled by a DDC controller.
2. Label each switch with valve designation served by switch.
3. Label switch positions to indicate either "Manual" or "Auto" control signal to valve.
4. With switch in "Auto" position, signal to control-valve actuator shall be a control loop output signal from DDC controller.
5. With switch in "Manual" position, signal to valve actuator shall be controlled at panel with either an integral or a separate switch to include local control.

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a. For Binary Control Dampers: Manual two-position switch shall have "Close" and "Open" switch positions indicated. With switch in "Close" position, damper shall close. With switch in "Open" position, damper shall open.
b. For Analog Control Dampers: A gradual switch shall have "Open" and "Close" switch limits indicated. Operator shall be able to rotate switch knob to adjust damper to any position from close to open.

6. DDC controller shall monitor and report position of each manual override selector switch. With switch placed in "manual" position, DDC controller shall signal an override condition to alert operator that valve is under manual, not automatic, control.

2.6 SYSTEM ARCHITECTURE

A. System architecture shall consist of no more than two or three levels of LANs.

1. Level one LAN shall connect network controllers and operator workstations.
2. Level two LAN shall connect programmable application controllers to other programmable application controllers, and to network controllers.

B. Minimum Data Transfer and Communication Speed:

1. LAN Connecting Operator Workstations and Network Controllers: 100 Mbps.
2. LAN Connecting Programmable Application Controllers: 1000 kbps.
3. LAN Connecting Application-Specific Controllers: 115,000 bps.

C. DDC system shall consist of dedicated LANs that are controlled and monitored by DEN IT.

D. System architecture shall be modular and have inherent ability to expand to not less than two times system size indicated with no impact to performance indicated.

E. System architecture shall perform modifications without having to remove and replace existing network equipment.

F. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.

G. Special Network Architecture Requirements:

1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling system air-handling unit(s). Create a DDC system LAN that aligns with air-handling system being controlled.
.

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2.7 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator shall access DDC system through DEN established control and security.

1. Day-to-day operation: via and DEN configured workstation with access to the system. These are specific machines at DEN and should be coordinated as required

2. For new work: desktop or portable operator workstation only during construction from a controlled and secured contractor location. This point of access is to be removed after work is completed.
3. Remote access: VIA a controlled and monitored Virtual server as determined by business needs.

B. Access to system, regardless of operator means used, shall be transparent to operator.

C. Network Ports: For hardwired connection of desktop or portable operator workstation. Network port shall be properly protected, clearly labeled, and installed at the following locations:

D. Desktop Workstations:

1. Provided, configured, and controlled by DEN.

E. Portable Workstations:

1. For DEN Maintenance staff only, Provided, configured, and controlled by DEN as needed.

F. Critical Alarm Reporting:

1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
3. DDC system shall notify recipients by e-mail

G. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

2.8 NETWORKS

A. Acceptable networks for connecting programmable application controllers include the following:

1. ASHRAE 135-2012 (BAcnet MS/TP)
2.

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B. Acceptable networks for connecting application-specific controllers include the following:

1. ASHRAE 135-2012 (BAcnet MS/TP)
2.

2.9 NETWORK COMMUNICATION PROTCOL

A. Network communication protocol(s) used throughout entire DDC system shall be open to public and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Operator workstations, controllers, and other network devices shall be tested and listed by BACnet Testing Laboratories.

5. Network and device controllers shall communicate through ASHRAE 135 protocol.
6. DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by BACnet Testing Laboratories.
7. Portions of DDC system networks using Modbus Application Protocol Specification V1.1b communication protocol shall be an open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b.
8. BACnet Gateways shall be used to connect any non-BACnet networks to the DEN EMCS.

A.

2.10 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating DOS and Microsoft Windows applications.

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3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software shall manage and control multiple network communications to provide exchange of global information and execution of global programs.
5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Operator sign-on and sign-off activity shall be recorded and sent to printer.
6. Security Access:

    a. Operator access to DDC system shall be controlled and integrated with the DEN Active Directory.
    b. An alphanumeric password shall be field assignable to each operator.
    c. Operators shall be able to access DDC system by entry of proper password.
    d. Operator password shall be same regardless of which computer or other interface means is used.
    e. Additions or changes made to passwords shall be updated automatically.
    f. Each operator shall be assigned an access level to restrict access to data and functions the operator is cable of performing.
    g. Software shall have at least five access levels.
    h. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
    i. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.

7. Operators shall be able to perform commands including, but not limited to, the following:

    a. Start or stop selected equipment.

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b. Adjust set points.
c. Add, modify, and delete time programming.
d. Enable and disable process execution.
e. Lock and unlock alarm reporting for each point.
f. Enable and disable totalization for each point.
g. Enable and disable trending for each point.
h. Override control loop set points.
i. Enter temporary override schedules.
j. Define holiday schedules.
k. Change time and date.
l. Enter and modify analog alarm limits.
m. Enter and modify analog warning limits.
n. View limits.
o. Enable and disable demand limiting.
p. Enable and disable duty cycle.
q. Display logic programming for each control sequence.

8. Reporting:

a. Generated automatically and manually.
b. Sent to displays, printers, and disk files.
c. Types of Reporting:

1) General listing of points.
2) List points currently in alarm.
3) List of off-line points.
4) List points currently in override status.
5) List of disabled points.
6) List points currently locked out.
7) List of items defined in a "Follow-Up" file.
8) List weekly schedules.
9) List holiday programming.
10) List of limits and deadbands.

9. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. Include a full interactive 3D graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color, and animation to facilitate operator understanding of system.

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3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Descriptors for graphics, points, alarms, and such shall be modified through operator's workstation under password control.
5. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
6. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
7. Graphics are to be online programmable and under password control.
8. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics shall also contain software points.
10. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
11. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
14. Include operator with means to directly access graphics without going through penetration path.
15. Dynamic data shall be assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
17. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
18. Points shall be dynamic with operator adjustable update rates on a per point basis from one second to over a minute.
19. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.

    a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
    b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
    c. Keyboard equivalent shall be available for those operators with that preference.

20. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
21. Help Features:

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a. On-line context-sensitive help utility to facilitate operator training and understanding.
b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation.

1) If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed word-processing program, which shall run concurrently with operating system software.

c. Available for Every Menu Item:

1) Index items for each system menu item.

22. Graphic generation software shall allow operator to add, modify, or delete system graphic displays.

a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols similar to those indicated.
b. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:

1) Define background screens.
2) Define connecting lines and curves.
3) Locate, orient, and size descriptive text.
4) Define and display colors for all elements.
5) Establish correlation between symbols or text and associated system points or other displays.

D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:

a. Room layouts with room identification and name.
b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
c. Location and identification of each hardware point being controlled or monitored by DDC system.

3. Control schematic for each of following, including a graphic system schematic representation, similar to that indicated on Drawings, with point identification, set point and dynamic value indication, sequence of operation and control logic diagram.

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4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, gateways operator workstations and other network devices.
6. Graphic displays shall be built using standard templates for similar pieces of equipment.

E. Customizing Software:

1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. As a minimum, include the following modification capability:

    a. Operator assignment shall include designation of operator passwords, access levels, point segregation, and auto sign-off.
    b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of printout of operator changes.
    c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics.
    d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.
    e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.
    f. Point related change capability shall include the following:

        1) System and point enable and disable.
        2) Run-time enable and disable.
        3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
        4) Assignment of alarm and warning limits.

    g. Application program change capability shall include the following:

        1) Enable and disable of software programs.
        2) Programming changes.

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3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.

4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices, and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.

5. Control point naming shall comply with the following schema. Control point name is a combination of the controller name and the point name. The controller name forms the first part of the overall point name and is common to all point names. Contractor to coordinate device and point naming with DEN Engineer and EMS/BAS Administrator. The overall point name syntax is:

   ControllerName.PointName

   The PointName consists of not more than three data fields, each not more than four characters in length. The first field identifies the primary equipment or piping system. The second field identifies secondary equipment found within the primary system, if necessary. The third field identifies the control point function. Point name field syntax is:

   PrimaryEquipment-SecondaryEquipment-Function

   Examples of PointName data field entries are:

Sys/Equip	Description		Function	Description
GLS	Glycol Supply Piping		C	Command
GLR	Glycol Return Piping		T	Temperature
PS01	Pump PS-01		P	Pressure
MV04	Motor Operated Valve MV-04		F	Flow
CWS	Condenser Water Supply Piping		S	Status
HWR	Heating Water Return Piping		SP	Setpoint
HX1	Heat Exchanger HX-01		FB	Feedback
			ALM	Alarm
			HT	High Temperature
			LT	Low Temperature

   Some examples:
   A digital output point which commands on pump PS-1 would be named: PS01-C

   A virtual point for a high temperature alarm in the GLR piping header would be named: GLR-HT-ALM

   A digital input from the open limit switch proving control valve MV-08 on heat exchanger HX-03 is fully open would be named: HX3-MV08-FBO

6. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.

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7. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:

    a. Proportional control (P).
    b. Proportional plus integral (PI).
    c. Proportional plus integral plus derivative (PID).
    d. Adaptive and intelligent self-learning control.

        1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
        2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.

8. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.

9. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.

10. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.

11. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.

F. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways and other network devices.
2. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display shall include the following:

    a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
    b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
    c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."

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d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.

5. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Send e-mail alarm messages to designated operators.
7. Send e-mail, page, text, and voice messages to designated operators for critical alarms.
8. Alarms shall be categorized and processed by class.

a. Class 1:

1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.

b. Class 2:

1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
2) Acknowledgement may be through a multiple alarm acknowledgment.

c. Class 3:

1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.
4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.

d. Class 4:

1) Routine maintenance or other types of warning alarms.
2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.

9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.

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10. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.

G. Reports and Logs:

1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
2. Each report shall be definable as to data content, format, interval, and date.
3. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on server for historical reporting.
4. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
5. Reports and logs shall be stored on workstation and server hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
6. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.

H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.

1. All I/O: With current status and values.
2. Alarm: All current alarms, except those in alarm lockout.
3. Disabled I/O: All I/O points that are disabled.
4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
6. Logs:

    a. Alarm history.
    b. System messages.
    c. System events.
    d. Trends.

I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.

J. HVAC Equipment Reports: Prepare Project-specific reports.

1. Chiller Report: Daily report showing operating conditions of each chiller according to ASHRAE 147, including, but not limited to, the following:

    a. Chilled-water entering temperature.
    b. Chilled-water leaving temperature.
    c. Chilled-water flow rate.
    d. Chilled-water inlet and outlet pressures.
    e. Evaporator refrigerant pressure and temperature.
    f. Condenser refrigerant pressure and liquid temperature.
    g. Condenser-water entering temperature.
    h. Condenser-water leaving temperature.

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i. Condenser-water flow rate.
j. Refrigerant levels.
k. Oil pressure and temperature.
l. Oil level.
m. Compressor refrigerant discharge temperature.
n. Compressor refrigerant suction temperature.
o. Addition of refrigerant.
p. Addition of oil.
q. Vibration levels or observation that vibration is not excessive.
r. Motor amperes per phase.
s. Motor volts per phase.
t. Refrigerant monitor level (PPM).
u. Ambient temperature (dry bulb and wet bulb).
v. Date and time logged.

K. Utility Reports: Prepare Project-specific reports.

1. Electric Report:

a. Include weekly report showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
b. Include monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each meter.
c. Include annual report showing the monthly electrical consumption and peak electrical demand with time and date stamp for each meter.
d. For each weekly, monthly, and annual report, include sum total of submeters combined by load type, such as lighting, receptacles, and HVAC equipment showing daily electrical consumption and peak electrical demand.
e. For each weekly, monthly, and annual report, include sum total of all submeters in building showing electrical consumption and peak electrical demand.

L. Energy Reports: Prepare Project-specific daily, weekly, monthly and annual energy reports.

1. Prepare report for each purchased energy utility, indicating the following:

a. Time period being reported with beginning and end date, and time indicated.
b. Consumption in units of measure commonly used to report specific utility consumption over time.
c. Gross area served by utility.
d. Consumption per unit area served using utility-specific unit of measure.
e. Cost per utility unit.
f. Utility cost per unit area.
g. Convert all utilities to a common energy consumption unit of measure and report for each utility.
h. Consumption per unit area using common unit of measure.

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2. Prepare purchased energy utility report for each submetered area that indicates the following:

    a. Time period being reported with beginning and end date, and time indicated.
    b. Gross area served.
    c. Energy consumption by energy utility type.
    d. Energy consumption per unit area by energy utility type.
    e. Total energy consumption of all utilities in common units of measure.
    f. Total energy consumption of all utilities in common units of measure per unit area.
    g. Unit energy cost by energy utility type.
    h. Energy cost by energy utility type.
    i. Energy cost per unit area by energy utility type.
    j. Total cost of all energy utilities.
    k. Total cost of all energy utilities per unit area.

3. Prepare Project total purchased energy utility report that combines all purchased energy utilities and all areas served. Project total energy report shall indicate the following:

    a. Time period being reported with beginning and end date, and time indicated.
    b. Gross area served.
    c. Energy consumption by energy utility type.
    d. Energy consumption per unit area by energy utility type.
    e. Total energy consumption of all utilities in common units of measure.
    f. Total energy consumption of all utilities in common units of measure per unit area.
    g. Unit energy cost by energy utility type.
    h. Energy cost by energy utility type.
    i. Energy cost per unit area by energy utility type.
    j. Total cost of all energy utilities.
    k. Total cost of all energy utilities per unit area.

M. HVAC System Efficiency Reports: Prepare Project-specific daily weekly monthly and annual HVAC system efficiency reports.

1. Prepare report for each chilled-water system, indicating the following:

    a. Time period being reported with beginning and end date, and time indicated.
    b. Cooling energy supplied during time period.
    c. Power energy consumed during time period by cooling equipment used to produce cooling energy supplied. List power consumed for each individual piece of equipment in system and summed total of all equipment in system.
    d. Energy efficiency coefficient of performance determined by dividing power energy consumed into cooling energy supplied.
    e. Energy efficiency determined by dividing cooling energy supplied into power energy consumed.

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f. Units of measure used in report shall be consistent with units indicated for system.

2. Prepare report for each hot-water system, indicating the following:

a. Time period being reported with beginning and end date, and time indicated.
b. Cooling energy supplied during time period.
c. Energy efficiency determined by dividing heating energy supplied into fuel energy consumed.
d. Units of measure used in report shall be consistent with units indicated for system.

N. Weather Reports:

1. Include daily, weekly, monthly and annual report showing the following:

a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
c. Daily minimum, maximum, and average outdoor dew point temperature.
d. Daily minimum, maximum, and average barometric pressure.
e. Daily minimum, maximum, and average wind speed, and direction.

O. Standard Trends:

1. Trend all I/O point present values, set points, and other parameters indicated for trending.
2. Trends shall be associated into groups, and a trend report shall be set up for each group.
3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching 75 of DDC controller buffer limit, or by operator request, or by archiving time schedule.
4. Preset trend intervals for each I/O point after review with Owner.
5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
6. When drive storage memory is full, most recent data shall overwrite oldest data.
7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.

P. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.

1. Each trend shall include interval, start time, and stop time.
2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on server hard drives.
3. Data shall be retrievable for use in spreadsheets and standard database programs.

Q. Programming Software:

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1. Include programming software to execute sequences of operation indicated.
2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
3. Programing software shall be as follows:

    a. Graphic Based: Programming shall use a library of function blocks made from preprogrammed code designed for DDC control systems.

        1) Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.
        2) Programming tools shall be viewable in real time to show present values and logical results of each function block.

    b. Menu Based: Programming shall be done by entering parameters, definitions, conditions, requirements, and constraints.
    c. Line by Line and Text Based: Programming shall declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.

4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

R. Database Management Software:

1. Where a separate SQL database is used for information storage, DDC system shall include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
2. Database secure access shall be accomplished using standard SQL authentication including ability to access data for use outside of DDC system applications.
3. Database management function shall include summarized information on trend, alarm, event, and audit for the following database management actions:

    a. Backup.
    b. Purge.
    c. Restore.

4. Database management software shall support the following:

    a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
    b. Maintenance: Include method of purging records from trend, alarm, event, and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
    c. Backup: Include means to create a database backup file and select a storage location.

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d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.

5. Database management software shall include information of current database activity, including the following:

a. Ready.
b. Purging record from a database.
c. Action failed.
d. Refreshing statistics.
e. Restoring database.
f. Shrinking a database.
g. Backing up a database.
h. Resetting Internet information services.
i. Starting network device manager.
j. Shutting down the network device manager.
k. Action successful.

6. Database management software monitoring functions shall continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and e-mail message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window shall have the following sections:

a. Allow operator to set and review scan intervals and start times.
b. E-mail: Allow operator to create and review e-mail and phone text messages to be delivered when a warning or an alarm is generated.
c. Warning: Allow operator to define warning limit parameters, set reminder frequency and link e-mail message.
d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency and link e-mail message.
e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event, and audit databases as well as operator proper security access to restore a database.

9. Monitoring settings taskbar shall include the following informational icons:

a. Normal: Indicates by color and size, or other easily identifiable means that all databases are within their limits.
b. Warning: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their warning limit.
c. Alarm: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their alarm limit.

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2.11 MAINTENANCE MANAGEMENT SOFTWARE

1. Include complete and functional software-driven maintenance management system. Software shall perform scheduling of preventive maintenance and generation of work orders, for mechanical and electrical equipment and systems.
2. Work orders shall be automatically generated from alarm conditions, run time, and calendar time. Each work order generated shall list parts, tools, craftspeople, and define task to be performed.
3. Work order generated shall be used to schedule a repair or preventive maintenance routine.
4. Work order shall be used to track completion of work, parts used and total cost of repair.
5. A database shall include an inventory tracking system. Work orders generated shall automatically update inventory database to show quantity of tools, repair parts, and expendables used for a work order.
6. Work orders and preventive maintenance schedules shall be printed on a dedicated printer assigned solely to maintenance management function.

B. Additional Hardware Requirements:

1. Maintenance management software shall not require additional hardware, except for an additional printer that is dedicated to maintenance management.
2. Maintenance management software shall be integrated into DDC system.

C. Software Requirements:

1. From main menu of maintenance management system, it shall be possible through selection of icons to penetrate to individual functions described below.
2. Work Orders:

    a. Automatically generate work orders initiated from alarm conditions, accumulated run time or calendar time. Work orders generated shall specify a particular task to be accomplished including the labor, material and tools needed to accomplish work.
    b. Include at least two of the following types of work orders:

        1) Corrective and emergency maintenance work orders shall be generated for a specific job or repair for emergency, breakdown, or scheduled work.
        2) Preventive maintenance that are used on a periodic basis to generate preventive maintenance work orders.

    c. Include the following functions:

        1) Work Order Tracking: Perform every function related to processing work orders including creating, approving and initiating work orders, checking their status history and closing or reworking them when appropriate.

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2) Work Requests: Report any problems that require corrective maintenance activity generated by dispatchers and those people designated to request work orders.
3) Quick Reporting: Report work done on an open work order or a small job.
4) Work Manager: Specify the type of labor to be applied to a specific work order at specific times. It shall include the capability to dispatch one or more laborers to top-priority jobs on as-needed basis and to interrupt work in progress to reassign labor to higher priority tasks.

d. Reports:

1) Daily Maintenance Schedule by Supervisor: List a schedule of open work orders for a specified date by supervisor.
2) Equipment Cost Roll-up Report: Include a roll-up of equipment costs incurred since the date the report was last run.
3) Delinquent Work Order Report: List open work orders whose target completion date is earlier than the date the report is run.
4) Employee Job Assignments: List labor codes that have job assignments for the specified date.
5) Daily Work Order Assignment: List work orders that have labor assignments for the specified date.
6) Estimated versus Actual Work Order Costs: List a cost summary of outstanding work orders.
7) Open Work Orders Report: List open work orders for locations and equipment.

3. Inventory:

a. Include an inventory tracking system to keep track of stocked, non-stocked and special-order items.
b. Link inventory tracking to database and when items are consumed, as noted on a work order issued by system, inventory of stocked items shall be automatically updated.
c. Include the following functions:

1) Inventory Control: Enter, display, and update information on each inventory item. It shall allow viewing of master inventory records that are independent of storeroom locations or item/location records. Include a screen that lists inventory transactions that move items in or out of inventory or from one storeroom location to another. Minimum information tracked shall include the following:

a) Vendors supply items.
b) Item balances, including the bin and lot level for each storeroom location.
c) Alternative items.

2) Issues and Transfers: Issue stock directly from inventory, with or without a work order. When transfer of stock from one location to

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another location occurs, provide appropriate adjustments in stock balance record. Include a trace record of stock transfers from one storeroom to another.

3) Item Assembly Structures: Include modeling of equipment with inventory items and building of equipment and location hierarchies.

4) Metered Material Usage:

a) Track usage by a piece of equipment.
b) Record against a standing work order for a selected piece of equipment.
c) Material usage transaction shall be written for each item of material used and be provided as an input to calculation for per unit material consumption report for a piece of equipment.

d. Reports:

1) Inventory Analysis Report: List for a given storeroom location, inventory items analysis information that allows quick identification of which inventory items represent greatest monetary investment for dollar value and rate of turnover.
2) Inventory Cycle Count Report: List for a specified storeroom, inventory items that are due to be cycle-counted, based on cycle-count frequency and last count date.
3) Economic Order Quantity Report: For a given storeroom location, display optimum economic ordering quantity for items in selected results set.
4) Inventory Pick Report: A pick list, by work order for items needed to be pulled from a designated storeroom's inventory for work orders having a target start date of specified date.
5) Suggested Order Report: List inventory items in selected results set that are due to be recorded, for a specified storeroom location, based on the following calculation: Suggest a reorder if current balance minus reserve quantity plus on-order quantity is less than reorder point.
6) Reorder Point Report: List selected set of items and optimum minimum level to have in stock based on demand, lead delivery time and a reserve safety stock.
7) Inventory Valuation Report: Gives an accounting of cost of current inventory, for inventory records in a designated storeroom location.
8) Item Order Status: Lists items on order.
9) List of Expired Items: Lists expired lot items in a storeroom. Report shall include item number, description, expiration date, bin number, lot number, manufacturer lot number, and quantity of expired items in that lot and bin.
10) Item Availability at All Locations: Lists alternative storeroom locations for selected items.
11) Where Used Report: List equipment on which item is recorded as being used.

4. Equipment:

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a. Include equipment and location records; establish relationships between equipment, between locations, and between equipment and locations; track maintenance costs; and enter and review meter readings.
b. Include the following functions:

1) Equipment: Store equipment numbers and corresponding information including equipment class, location, vendor, up/down status and maintenance costs for each piece of equipment. Include building of equipment assemblies. Equipment assemblies hierarchical ordering shall be provided for arrangement of buildings, departments, equipment, and sub-assemblies.
2) Operating Locations: Facilitate creation of records for operating locations of equipment, and track equipment that is used in multiple locations. In addition, allow hierarchical organization of equipment operating in facility by means of grouping equipment locations into areas of responsibility.
3) Failure Codes: Develop and display failure hierarchies to acquire an accurate history of types of failures that affect equipment and operating locations.
4) Condition Monitoring: Display time related or limit measurements recorded for a piece of equipment. It shall be possible to generate work orders from this screen and to take immediate action on problem conditions.

c. Reports:

1) Availability Statistic by Location: List equipment availability by location over a user-specified time period.
2) Equipment Failure Summary: List total number of failures by problem code for a piece of equipment for a specified time period.
3) Detailed Equipment Failure Report by Equipment: List of failure reports for the current piece of equipment for a specified time period.
4) Equipment Hierarchy Report: List of equipment.
5) Equipment History Graphs: Include a graphical report in histogram format that displays equipment breakdown history over a specified period.
6) Equipment Measurement Report: Tabular listing and description of each measurement point for a piece of equipment and the history of measurements taken for that point.
7) Maintenance Cost by Equipment: List of transactions costs for elected equipment in the specified date range.
8) Failure Count by Equipment: Graphically report the number of failures for each piece of equipment showing number of failures for each piece of equipment over a specified time period, occurrence of each problem code within set of failures and failures by problem code.
9) Failure Analysis Graphs: Graphically report number of failures for each piece of equipment over a specified time period, number of occurrences of each problem code within set of failures and failures by problem code.

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10) Failure Code Hierarchy Report: List of failure codes in each level of the failure hierarchy.
11) Location Failure Summary: A summary for each selected location of failures reported and any hierarchy level locations for specified time period.
12) Failure Summary by Location: A summary of failures for the selected location and their subordinate locations that are part of the hierarchical system.
13) Detailed Failure Report by Location: List all failures for selected location and its subordinate locations that are part of a hierarchical system.
14) Maintenance Cost by System: List of total costs reported in a given date range for locations in selected hierarchical system.
15) Location Hierarchy Report: Lists member locations of a hierarchical system displayed in hierarchical fashion.

5. Purchasing:

a. Include preparation and generation of purchase requisitions and purchase orders; to report receipt of both items and services, match invoices with purchase orders and receipts and define and convert foreign currencies.
b. Include the following functions:

1) Purchase Requisition: Create and process purchase requisitions for items and services.
2) Purchase Orders: Create and process purchase orders for items and services from scratch or from purchase requisitions. Record receipts of items and services.
3) Invoices: Include functionality to match purchase orders with invoices and receipts. It shall also be possible to match a service receipt to an invoice. Project for entering of an invoice for bills that do not require purchase orders or receipts.
4) Currency Management: Define currencies and specify exchange rates. Include preparation of purchase requisitions and purchase orders in currency of vendor, while tracking costs in systems base currency.

c. Reports:

1) Invoice Approval Report: Include an approval form for entered invoices.
2) Inventory Receipts Register: List purchase orders and inventory received for the user-specified time frame.
3) Direct Purchase Back-Order Report: List of items ordered as a direct purchase not received by the required delivery date.
4) Standard Purchase Order: A printing of primary purchase order with vendors shipping information, and items purchased.
5) Purchase Order Status Report: List of purchase orders whose status has changed during a certain time period.

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6) Standard Purchase Requisition: A printing of primary purchase requisition, including vendor name and shipping information.

6. Job Plans:

a. Include creation of a detailed description of work to be performed by a work order. The job plan shall contain operations, procedures, and list of estimated material, labor, and tools required for work.

7. Labor:

a. Store information on employees, contractors, and crafts and include the following functions:

1) Labor: Create, modify, and view employee records. Employee records shall contain pay rate, overtime worked, overtime refused, specials skills and certifications.
2) Crafts: Create, modify, and view craftspeople records.
3) Labor Reporting: Report labor usage by employee or craft externally from the work orders module.

b. Reports:

1) Employee Attendance Analysis: List of planned attendance, actual attendance, vacation, and sick time in hours as a percentage of planned attendance for selected employees for specified time period.
2) Labor Productivity Analysis: List of actual labor hours by labor report category showing each by percentage.
3) Labor Availability versus Commitments by Crafts: A graphical report that details available labor hours versus committed work order hours by craft and day.

8. Calendars:

a. Establish calendar records indicating working time for equipment, location, craft, and labor records.

9. Resources:

a. Include entry and retrieval of data associated with resources required to maintain facility and to include the following functions:

1) Companies: Establish and update data on vendors and other companies.
2) Tools: Create and maintain information on the tools used on jobs. The information contained within this module shall be available to job plans and work orders.
3) Service Contracts: Specify information on service contracts with vendors or manufacturers.

10. Custom Applications:

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a. Include creation of customized database tables and application screens that supplement functions specified.

11. Setup:

a. Include configuration of database, security, and setup applications.
b. Perform the following functions:

1) Reports and Other Applications: Register reports and other applications for use within system.
2) Documents: Enter, track, and link information from Drawings to equipment and inventory items.
3) Chart of Accounts: Add or modify accounts; set up financial periods; enter inventory accounts, company accounts, and resource recovery accounts; and define tax codes and rates.
4) Signature Security: Establish each user's access rights to modules, applications, screens, and options.
5) Database Configuration: Customize database, including adjusting field lengths and modifying data types.
6) Application Setup: Change position of icons and menu items on the main menu screen.
7) Application Launching: Allow for connecting of third-party applications to data fields and push buttons.

12. Utilities:

a. Include utilities module that allows system administrator to customize system and to maintain database.
b. Include the following functions:

1) Interactive SQL: Include access to database for database management functions of import/export and backup.
2) Edit Windows: Display a dialog box to customize an application.
3) Archive Data: Remove records from database and store them for future reference.

D. Documentation:

1. Include complete documentation for the system consisting of a User Manual and Systems Administrator Guide.
2. User Manual shall describe how to use each application module and screen with step-by-step instructions detailing entry and retrieval of data for functions specified.
3. Include a step-by-step description of how each report is defined and retrieved.
4. Bind documentation and clearly title it indicating volume number and use.

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2.12 ASHRAE 135 GATEWAYS

A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, and variable-speed drives.

B. Include gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment, only when specifically requested and approved by Owner.

C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.

D. Gateway Minimum Requirements:

1. Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.
2. Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.
3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.
4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.
5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
6. Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

2.13 ASHRAE 135 PROTOCOL ANALYZER

A. Analyzer and required cables and fittings for connection to ASHRAE 135 network.

B. Analyzer shall include the following minimum capabilities:

1. Capture and store to a file data traffic on all network levels.
2. Measure bandwidth usage.
3. Filtering options with ability to ignore select traffic.

2.14 DDC CONTROLLERS

A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.

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B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.

C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.

D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.

E. Environment Requirements:

1. Controller hardware shall be suitable for the anticipated ambient conditions.
2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F (Zero to 50 deg C).
3.

F. Power and Noise Immunity:

1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches (900 mm) of enclosure.

G. DDC Controller Spare Processing Capacity:

1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:

    a. Network Controllers: 50 percent.
    b. Programmable Application Controllers: Not less than 60 percent.
    c. Application-Specific Controllers: Not less than 70 percent.

2. Memory shall support DDC controller's operating system and database and shall include the following:

    a. Monitoring and control.
    b. Energy management, operation, and optimization applications.
    c. Alarm management.
    d. Historical trend data of all connected I/O points.
    e. Maintenance applications.
    f. Operator interfaces.
    g. Monitoring of manual overrides.

H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:

1. Network Controllers:

    a. 10 percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:

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1) AIs: Three.
2) AOs: Three.
3) BIs: Five.
4) BOs: Five.

2. Programmable Application Controllers:

a. 10 percent of each AI, AO, BI, and BO point connected to controller.
b. Minimum Spare I/O Points per Controller:

1) AIs: Three.
2) AOs: Three.
3) BIs: Five.
4) BOs: Five.

3. Application-Specific Controllers:

a. 10 percent of each AI, AO, BI, and BO point connected to controller.
b. Minimum Spare I/O Points per Controller:

1) AIs: Two.
2) AOs: Two.
3) BIs: Two.
4) BOs: Two.

I. Maintenance and Support: Include the following features to facilitate maintenance and support:

1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.
4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

J. Input and Output Point Interface:

1. Hardwired input and output points shall connect to network, programmable application, and application-specific controllers.
2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:

a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.

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c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
d. Signal conditioning including transient rejection shall be provided for each AI.
e. Capable of being individually calibrated for zero and span.
f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.

5. AOs:

a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
b. Output signals shall have a range of 4 to 20 mA dc or zero- to 10-V dc as required to include proper control of output device.
c. Capable of being individually calibrated for zero and span.
d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.

6. BIs:

a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.

7. BOs:

a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.

1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.

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b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
c. BOs shall be selectable for either normally open or normally closed operation.
d. Include tristate outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.

2.15 NETWORK CONTROLLERS

A. General Network Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers that perform scheduling shall have a real-time clock.
7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.

B. Communication:

1. Network controllers shall communicate with other devices on DDC system Level one network.
2. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 96 hours.

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2.16 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.
3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers that perform scheduling shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:

1. Programmable application controllers shall communicate with other devices on network.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.17 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and shall continue to include control functions without being connected to network.
2. Data shall be shared between networked controllers and other network devices.

B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.

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C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.18 CONTROLLER SOFTWARE

A. General Controller Software Requirements:

1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
2. I/O points shall be identified by up to 30-character point name and up to 16-character point descriptor. Same names shall be used at operator workstations.
3. Control functions shall be executed within controllers using DDC algorithms.
4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.

B. Security:

1. Operator access shall be secured using individual security passwords and user names.
2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
3. Operator log-on and log-off attempts shall be recorded.
4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.

C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:

1. Weekly Schedule:

a. Include separate schedules for each day of week.
b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
c. Each schedule may consist of up to 10 events.
d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.

2. Exception Schedules:

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a. Include ability for operator to designate any day of the year as an exception schedule.
b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.

3. Holiday Schedules:

a. Include capability for operator to define up to 99 special or holiday schedules.
b. Schedules may be placed on scheduling calendar and will be repeated each year.
c. Operator shall be able to define length of each holiday period.

D. System Coordination:

1. Include standard application for proper coordination of equipment.
2. Application shall include operator with a method of grouping together equipment based on function and location.
3. Group may then be used for scheduling and other applications.

E. Binary Alarms:

1. Each binary point shall be set to alarm based on operator-specified state.
2. Include capability to automatically and manually disable alarming.

F. Analog Alarms:

1. Each analog object shall have both high and low alarm limits.
2. Alarming shall be able to be automatically and manually disabled.

G. Alarm Reporting:

1. Operator shall be able to determine action to be taken in event of an alarm.
2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.

H. Remote Communication:

1. System shall have ability to dial out in the event of an alarm.

I. Electric Power Demand Limiting:

1. Demand-limiting program shall monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
2. Demand-limiting program shall predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined

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manner. When demand prediction indicates demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.

3. Demand reduction shall be accomplished by the following means:

    a. Reset air-handling unit supply temperature set points.
    b. Reset space temperature set points.
    c. De-energize equipment based on priority.

4. Demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables shall be based on how electric power service provider computes demand charges.
5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
6. Include means operator to make the following changes online:

    a. Addition and deletion of loads controlled.
    b. Changes in demand intervals.
    c. Changes in demand limit for meter(s).
    d. Maximum shutoff time for equipment.
    e. Minimum shutoff time for equipment.
    f. Select rotational or sequential shedding and restoring.
    g. Shed and restore priority.

7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly and annual basis:

    a. Total electric consumption.
    b. Peak demand.
    c. Date and time of peak demand.
    d. Daily peak demand.

J. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

K. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

L. Control Loops:

1. Support any of the following control loops, as applicable to control required:

    a. Two-position (on/off, open/close, slow/fast) control.
    b. Proportional control.
    c. Proportional plus integral (PI) control.
    d. Proportional plus integral plus derivative (PID) control.

        1) Include PID algorithms with direct or reverse action and anti-windup.
        2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.

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3) Controlled variable, set point, and PID gains shall be operator-selectable.

e. Adaptive (automatic tuning).

M. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.

N. Energy Calculations:

1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

O. Anti-Short Cycling:

1. BO points shall be protected from short cycling.
2. Feature shall allow minimum on-time and off-time to be selected.

P. On and Off Control with Differential:

1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.
2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.

Q. Run-Time Totalization:

1. Include software to totalize run-times for all BI [**and BO**]points.
2. A high run-time alarm shall be assigned, if required, by operator.

2.19 ENCLOSURES

A. General Enclosure Requirements:

1. House each controller and associated control accessories in aenclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Do not house more than one controller in a single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.

B. Internal Arrangement:

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1. Internal layout of enclosure shall group and protect pneumatic, electric, and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling, and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 20 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch- (6-mm-) high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable, wire, and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

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D. Wall-Mounted, NEMA 250, Type 1:

1. Enclosure shall be NRTL listed according to UL 50 or UL 50E.
2. Construct enclosure of steel, not less than:

    a. Enclosure size less than 24 in. (600 mm): 0.053 in. (1.35 mm) or 0.067 in. (1.7 mm) thick.
    b. Enclosure size 24 in. (600 mm) and larger: 0.067 in. (1.7 mm) or 0.093 in. (2.36 mm) thick.

3. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior color shall be manufacturer's standard.
    b. Interior color shall be manufacturer's standard.

4. Hinged door full size of front face of enclosure and supported using:

    a. Enclosures sizes less than 36 in. (900 mm) tall: Multiple butt hinges.
    b. Enclosures sizes 36 in. (900 mm) tall and larger: Continuous piano hinges.

5. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Size less than 24 in. (600 mm): Solid steel, 0.053 in. (1.35 mm) thick.
    b. Size 24 in. (600 mm) and larger: Solid aluminum, 0.10 in. (3 mm) or steel, 0.093 in. (2.36 mm) thick.

6. Internal panel mounting hardware, grounding hardware, and sealing washers.
7. Grounding stud on enclosure body.
8. Thermoplastic pocket on inside of door for record Drawings and Product Data.

E. Wall Mounted NEMA 250, Types 4 and 12:

1. Enclosure shall be NRTL listed according to UL 508A.
2. Seam and joints are continuously welded and ground smooth.
3. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
5. Single-door enclosure sizes up to 60 inches tall by 36 inches wide (1500 mm tall by 900 mm wide).
6. Double-door enclosure sizes up to 36 inches tall by 60 inches wide (900 mm tall by 1500 mm wide).
7. Construct enclosure of steel, not less than the following:

    a. Size Less Than 24 Inches (600 mm): 0.053 inch (1.35 mm) or 0.067 inch (1.7 mm) thick.
    b. Size 24 Inches (600 mm) and larger: 0.067 inch (1.7 mm) thick.

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8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior color shall be manufacturer's standard.
    b. Interior color shall be manufacturer's standard.

9. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.

    a. Sizes through 24 Inches (600 mm) tall: Two hinges.
    b. Sizes between 24 Inches (600 mm) through 48 Inches (1200 mm) Tall: Three hinges.
    c. Sizes Larger 48 Inches (1200 mm) tall: Four hinges.

10. Double-door enclosures with overlapping door design to include unobstructed full-width access.

    a. Single-door enclosures 48 inches (1200 mm) and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.

11. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Size Less Than 24 Inches (600 mm): Solid steel, 0.053 inch (1.35 mm) thick.
    b. Size 24 Inches (600 mm) and larger: Solid aluminum, 0.10 inch (3 mm) or steel, 0.093 inch (2.36 mm) thick.

12. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
13. Grounding stud on enclosure body.
14. Thermoplastic pocket on inside of door for record Drawings and Product Data.

F. Freestanding, NEMA 250, Types 4 and 12:

1. Enclosure shall be NRTL listed according to UL 508A.
2. Seam and joints are continuously welded and ground smooth.
3. Externally formed body flange around perimeter of enclosure face.
4. Type 12 Enclosure Sizes:

    a. Single-door enclosure sizes up to 90 inches tall by 36 inches wide (2250 mm tall by 900 mm wide).
    b. Double-door enclosure sizes up to 90 inches tall by 72 inches wide (2250 mm tall by 900 mm wide).

5. Type 4 Enclosure Sizes:

    a. Single-door enclosure sizes up to 72 inches tall by 36 inches wide (1800 mm tall by 900 mm wide).

6. Construct enclosure of steel, not less than 0.093 inch (2.36 mm) thick.

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7. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior color shall be manufacturer's standard.
    b. Interior color shall bemanufacturer's standard.

8. Corner-formed door with continuous perimeter oil-resistant gasket supported using continuous piano hinge full length of door.
9. Doors fitted with three-point (top, middle, and bottom) latch system with latching rod rollers and single, heavy-duty oil-tight handle with integral locking mechanism.
10. Removable solid steel internal panel, 0.093 inch (2.36 mm) thick, with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
11. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
12. Grounding stud on enclosure body.
13. Thermoplastic pocket on inside of door for record Drawings and Product Data.
14. Top of enclosure fitted with no fewer than two lifting eyes.
15. Internal rack-mount shelves and angles as required by application.

2.20 RELAYS

A. General-Purpose Relays:

1. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Relays shall have LED indication and a manual reset and push-to-test button.
7. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Pickup Time: 15 ms or less.
    d. Dropout Time: 10 ms or less.
    e. Pull-in Voltage: 85 percent of rated voltage.
    f. Dropout Voltage: 50 percent of nominal rated voltage.
    g. Power Consumption: 2 VA.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F (Minus 40 to 46 deg C).

8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.

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10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Multifunction Time-Delay Relays:

1. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.
2. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval, and recycle timing functions.
3. Use a plug-in-style relay with either an 8- or 11-pin octal plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a dust-tight cover.
6. Include knob and dial scale for setting delay time.
7. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
    d. Repeatability: Within 2 percent.
    e. Recycle Time: 45 ms.
    f. Minimum Pulse Width Control: 50 ms.
    g. Power Consumption: 5 VA or less at 120-V ac.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F (Minus 40 to 46 deg C).

8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

C. Latching Relays:

1. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
2. Relays shall be either DPDT or three-pole double throw, depending on the control application.
3. Use a plug-in-style relay with a multibladed plug.
4. Construct the contacts of either silver cadmium oxide or gold.
5. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
6. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Pickup Time: 15 ms or less.
    d. Dropout Time: 10 ms or less.
    e. Pull-in Voltage: 85 percent of rated voltage.
    f. Dropout Voltage: 50 percent of nominal rated voltage.
    g. Power Consumption: 2 VA.

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h. Ambient Operating Temperatures: Minus 40 to 115 deg F (Minus 40 to 46 deg C).

7. Equip relays with coil transient suppression to limit transients to non-damaging levels.
8. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
9. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

D. Current Sensing Relay:

1. Monitors ac current.
2. Independent adjustable controls for pickup and dropout current.
3. Energized when supply voltage is present and current is above pickup setting.
4. De-energizes when monitored current is below dropout current.
5. Dropout current is adjustable from 50 to 95 percent of pickup current.
6. Include a current transformer, if required for application.
7. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

E. Combination On-Off Status Sensor and On-Off Relay:

1. Description:

a. On-off control and status indication in a single device.
b. LED status indication of activated relay and current trigger.
c. Closed-Open-Auto override switch located on the load side of the relay.

2. Performance:

a. Ambient Temperature: Minus 30 to 140 deg F (Minus 34 to 60 deg C).
b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.

3. Status Indication:

a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
b. Current Sensor Range: As required by application.
c. Current Set Point: Fixed or adjustable as required by application.
d. Current Sensor Output:

1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
3) Analog, zero- to 5- or 10-V dc.
4) Analog, 4 to 20 mA, loop powered.

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4. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
5. Enclosure: NEMA 250, Type 1 enclosure.

2.21 ELECTRICAL POWER DEVICES

A. Transformers:

1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
2. Transformer shall be at least 40 VA.
3. Transformer shall have both primary and secondary fuses.

B. Power-Line Conditioner:

1. General Power-Line Conditioner Requirements:

a. Design to ensure maximum reliability, serviceability, and performance.
b. Overall function of the power-line conditioner is to receive raw, polluted electrical power and purify it for use by electronic equipment. The power-line conditioner shall provide isolated, regulated, transient, and noise-free sinusoidal power to loads served.

2. Standards: NRTL listed per UL 1012.
3. Performance:

a. Single phase, continuous, 100 percent duty rated KVA/KW capacity. Design to supply power for linear or nonlinear, high crest factor, resistive and reactive loads.
b. Automatically regulate output voltage to within 2 percent or better with input voltage fluctuations of plus 10 to minus 20 percent of nominal when system is loaded 100 percent. Use Variable Range Regulation to obtain improved line voltage regulation when operating under less than full load conditions.

1) At 75 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 35 percent of nominal.
2) At 50 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 40 percent of nominal.
3) At 25 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 45 percent of nominal.

c. With input voltage distortion of up to 40 percent, limit the output voltage sine wave to a maximum harmonic content of 5 percent.
d. Automatically regulate output voltage to within 2.5 percent when load (resistive) changes from zero percent to 100 percent to zero percent.

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e. Output voltage returns to 95 percent of nominal level within two cycles and to 100 percent within three cycles when the output is taken from no load to full resistive load or vice-versa. Recovery from partial resistive load changes is corrected in a shorter period of time.
f. K Factor: 30, designed to operate with nonlinear, non-sinusoidal, high crest factor loads without overheating.
g. Input power factor within 0.95 approaching unity with load power factor as poor as 0.6.
h. Attenuate load-generated odd current harmonics 23 dB at the input.
i. Electrically isolate the primary from the secondary. Meet isolation criteria as defined in NFPA 70, Article 250-5D.
j. Lighting and Surge Protection: Compares to UL 1449 rating of 330 V when subjected to Category B3 (6000 V/3000 A) combination waveform as established by IEEE C62.41.
k. Common-mode noise attenuation of 140 dB.
l. Transverse-mode noise attenuation of 120 dB.
m. With loss of input power for up to 16.6 ms, the output sine wave remains at usable ac voltage levels.
n. Reliability of 200,000 hours' MTBF.
o. At full load, when measured at 1-m distance, audible noise is not to exceed 54 dB.
p. Approximately 92 percent efficient at full load.

4. Transformer Construction:

a. Ferroresonant, dry type, convection cooled, 600V class. Transformer windings of Class H (220 deg C) insulated copper.
b. Use a Class H installation system throughout with operating temperatures not to exceed 150 deg C over a 40-deg C ambient temperature.
c. Configure transformer primary for multi-input voltage. Include input terminals for source conductors and ground.
d. Manufacture transformer core using M-6 grade, grain-oriented, stress-relieved transformer steel.
e. Configure transformer secondary in a 240/120-V split with a 208-V tap or straight 120 V, depending on power output size.
f. Electrically isolate the transformer secondary windings from the primary windings. Bond neutral conductor to cabinet enclosure and output neutral terminal.
g. Include interface terminals for output power hot, neutral and ground conductors.
h. Label leads, wires, and terminals to correspond with circuit wiring diagram.
i. Vacuum impregnate transformer with epoxy resin.

5. Cabinet Construction:

a. Design for panel or floor mounting.
b. NEMA 250, Type 1, general-purpose, indoor enclosure.
c. Manufacture the cabinet from heavy gauge steel complying with UL 50.
d. Include a textured baked-on paint finish.

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C. Transient Voltage Suppression and High-Frequency Noise Filter Unit:

1. The maximum continuous operating voltage shall be at least 125 percent.
2. The operating frequency range shall be 47 to 63 Hz.
3. Protection modes according to NEMA LS-1.
4. The rated single-pulse surge current capacity, for each mode of protection, shall be no less than the following:

    a. Line to Neutral: 45,000 A.
    b. Neutral to Ground: 45,000 A.
    c. Line to Ground: 45,000 A.
    d. Per Phase: 90,000 A.

5. Clamping voltages shall be in compliance with test and evaluation procedures defined in NEMA LS-1. Maximum clamping voltage shall be as follows:

    a. Line to Neutral: 360 V.
    b. Line to Ground: 360 V.
    c. Neutral to Ground: 360 V.

6. Electromagnetic interference and RF interference noise rejection or attenuation values shall comply with test and evaluation procedures defined in NEMA LS-1.

    a. Line to Neutral:

        1) 100 kHz: 42 dB.
        2) 1 MHz: 25 dB.
        3) 10 MHz: 21 dB.
        4) 100 MHz: 36 dB.

    b. Line to Ground:

        1) 100 kHz: 16 dB.
        2) 1 MHz: 55 dB.
        3) 10 MHz: 81 dB.
        4) 100 MHz: 80 dB.

7. Unit shall have LED status indicator that extinguishes to indicate a failure.
8. Unit shall be listed by an NRTL as a transient voltage surge suppressor per UL 1449, and as an electromagnetic interference filter per UL 1283.
9. Unit shall not generate any appreciable magnetic field.
10. Unit shall not generate an audible noise.

D. DC Power Supply:

1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
2. Enclose circuitry in a housing.

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3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
4. Performance:

    a. Output voltage nominally 25-V dc within 5 percent.
    b. Output current up to 100 mA.
    c. Input voltage nominally 120-V ac, 60 Hz.
    d. Load regulation within 0.5 percent from zero- to 100-mA load.
    e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
    f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

2.22 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

A. 250 through 1000 VA:

1. UPS units shall provide continuous, regulated output power without using their batteries during brownout, surge, and spike conditions.
2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.

    a. Larger-capacity units shall be provided for systems with larger connected loads.
    b. UPS shall provide five minutes of battery power.

3. Performance:

    a. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
    b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
    c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152-V ac.
    d. On Battery Output Voltage: Sine wave.
    e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
    f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
    g. Transfer Time: 6 ms.
    h. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.

4. UPS shall be automatic during fault or overload conditions.
5. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
6. Include front panel with power switch and visual indication of power, battery, fault, and temperature.
7. Unit shall include an audible alarm of faults and front panel silence feature.
8. Unit with four NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.

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9. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure) and connect the points to the DDC system.
10. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.
11. Include tower models installed in ventilated cabinets to the particular installation location.

B. 1000 through 3000 VA:

1. UPS units shall provide continuous, regulated output power without using their batteries during brownout, surge, and spike conditions.
2. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.

    a. Larger-capacity units, or multiple units, shall be provided for systems with larger connected loads.
    b. UPS shall provide 10 minutes of battery power.

3. Performance:

    a. Input Voltage: Single phase, 120-V ac, plus 20 to minus 30 percent.
    b. Power Factor: Minimum 0.97 at full load.
    c. Output Voltage: Single phase, 120-V ac, within 3 percent, steady state with rated output current of 10.0 A, 30.0-A peak.
    d. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
    e. Recharge time shall be a maximum of eight hours to 90 percent capacity.

4. UPS bypass shall be automatic during fault or overload conditions.
5. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure) and connect the points to the DDC system.
6. Batteries shall be sealed lead-acid type and be maintenance free.
7. Include tower models installed in ventilated cabinets or rack models installed on matching racks, as applicable to the particular installation location and space availability/configuration.

2.23 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire size shall be at least No. 16 AWG.
2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch (50- to 65-mm) lay.
3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
4. Conductor colors shall be black (hot), white (neutral), and green (ground).
5. Furnish wire on spools.

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B. Single Twisted Shielded Instrumentation Cable above 24 V:

1. Wire size shall be a minimum No. 18 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch (50- to 65-mm) lay.
3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red, and white.
7. Furnish wire on spools.

C. Single Twisted Shielded Instrumentation Cable 24 V and Less:

1. Wire size shall be a minimum No. 18 AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch (50- to 65-mm) lay.
3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red, and white.
7. Furnish wire on spools.

D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1. Cable shall be plenum rated.
2. Cable shall comply with NFPA 70.
3. Cable shall have a unique color that is different from other cables used on Project.
4. Copper Cable for Ethernet Network:

    a. 100BASE-TX 1000BASE-T or 1000BASE-TX.
    b. TIA/EIA 586, Category 5e or Category 6.
    c. Minimum No. 22 AWG solid.
    d. Shielded Twisted Pair (STP).
    e. Thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, Class CMP as plenum rated.

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2.24 RACEWAYS FOR CONTROL WIRING, CABLING, AND TUBING

A. Metal Conduits, Tubing, and Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AFC Cable Systems Inc.
    b. Allied Tube & Conduit.
    c. Anamet Electrical, Inc.
    d. Current Technology Inc.
    e. Electri-Flex Company.
    f. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
    g. Picoma Industries.
    h. Republic Conduit.
    i. Robroy Industries.
    j. Southwire Company.
    k. Western Tube and Conduit Corporation.
    l. Wheatland Tube Company.

2. 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.
3. GRC: Comply with NEMA ANSI C80.1 and UL 6.
4. ARC: Comply with NEMA ANSI C80.5 and UL 6A.
5. IMC: Comply with NEMA ANSI C80.6 and UL 1242.
6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

    a. Comply with NEMA RN 1.
    b. Coating Thickness: 0.040 inch (1 mm), minimum.

7. EMT: Comply with NEMA ANSI C80.3 and UL 797.
8. FMC: Comply with UL 1; zinc-coated steel or aluminum.
9. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
10. Fittings for Metal Conduit: Comply with NEMA ANSI FB 1 and UL 514B.
    a. Fittings for EMT:

        1) Material: Steel or die cast.
        2) Type: Setscrew or compression.

    b. 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.
    c. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

11. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for

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use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

B. Nonmetallic Conduits, Tubing, and Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AFC Cable Systems.
   b. Anamet Electrical, Inc.
   c. CANTEX Inc.
   d. Carlon Electrial Products.
   e. CertainTeed Corporation.
   f. Condux International, Inc.
   g. Current Technology Inc.
   h. Dura-Line.
   i. Electri-Flex Company.
   j. Kraloy.
   k. Niedax-Kleinhuis USA, Inc.
   l. RACO; Hubbell.

2. 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.
3. ENT: Comply with NEMA TC 13 and UL 1653.
4. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
5. LFNC: Comply with UL 1660.
6. Rigid HDPE: Comply with UL 651A.
7. Continuous HDPE: Comply with UL 651A.
8. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.
9. RTRC: Comply with UL 2515A and NEMA TC 14.
10. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
11. Fittings for LFNC: Comply with UL 514B.

C. Metal Wireways and Auxiliary Gutters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Cooper B-Line, Inc.; a division of Cooper Industries.
   b. Hoffman; a brand of Pentair Equipment Protection.
   c. MonoSystems, Inc.
   d. Square D; by Schneider Electric.

2. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 4 Type 12 unless otherwise indicated, and sized according to NFPA 70.

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a. 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.

3. 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.
4. Wireway Covers: Hinged type unless otherwise indicated.
5. Finish: Manufacturer's standard enamel finish.

D. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color as selected by Architect.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. MonoSystems, Inc.
b. Panduit Corp.
c. Wiremold / Legrand.

2.25 CONTROL POWER WIRING AND RACEWAYS

A. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" electrical power conductors and cables.

B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

2.26 FIBER-OPTIC CABLE, CONNECTORS, AND RACEWAY

A. Cables:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMP NETCONNECT; a Tyco Electronics brand, a TE Connectivity Ltd. company.
b. AT&T.
c. Belden Inc.
d. Berk-Tek.
e. Communications Specialties, Inc.
f. Corning Cable Systems.
g. Optical Cable Corporation.
h. Times Fiber Communications, Inc.

2. Performance Requirements:

a. Fiber: Multimode graded index. Core/cladding size shall be either 62.5/125 or 100/140 micrometers.

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b. Numerical Aperture:

1) 62.5/125 Micrometer Fiber: 0.275 plus or minus 0.015.
2) 100/140 Micrometer Fiber: 0.29 plus or minus 0.015.

c. Maximum Attenuation:

1) 850 nm: 6.0 dB/km.
2) 1300 nm: 5.0 dB/km.

d. Minimum Bandwidth Dispersion: 300 Mhz-km at 850 nm.
e. Core/Cladding Index Difference: 0.3 percent plus or minus 0.05 percent, measured using refractive rear field measurement procedure.
f. Color-code finished fibers for easy identification.
g. Splice Loss: Fibers shall be spliced together to form a longer fiber using a commercially available fiber splicing machine recommended by cable manufacturer. Maximum loss per fiber splice shall be 0.20 dB.
h. Connection: Fibers shall be connected using fiber-optic connectors. Nominal connector loss shall not be greater than 1 dB.
i. Fiber-optic cable shall be suitable for use with 100Base-FX or 100Base-SX standard (as applicable) as defined in IEEE 802.3.

3. Mechanical and Environmental Requirements:

a. Tensile Strength: Fiber cable shall withstand a minimum tensile strength of 2700 N with maximum elongation of less than 0.5 percent.
b. Bending Radius: Minimum static bending radius for cable shall be 10 times outside diameter for non-armored cables and 20 times outside diameter for armored cables. Non-armored cables shall withstand being flexed at minimum static bending radius plus or minus 90 degrees for at least 20 cycles at 20 to 40 cycles per minute at 20 deg C. Armored cables shall withstand being flexed at minimum static bending radius plus or minus 90 degrees for at least 10 cycles at 20 to 40 cycles per minute at 20 deg C.
c. Vibration: Cable shall withstand a vibration test with vibration amplitude of 5 mm and frequency of 10 cycles per second for at least five hours.
d. Twist: Cable shall withstand twisting of 360 degrees over a length of 2 m for at least 10 cycles at 10 cycles per minute.
e. Temperature: Cable shall withstand the following temperatures:

1) Installation: Minus 30 to 70 deg C.
2) Operation: Minus 40 to 70 deg C.
3) Storage/Shipping: Minus 40 to 70 deg C.

f. Lifetime: Average lifetime of a 2-km, 12-fiber cable shall be at least 20 years when installed in a natural ambient environment. End of useful life shall be reached if failing to comply with requirements indicated or a spontaneous catastrophic fiber failure.
g. Crush Resistance: Cable shall withstand a compressive force of 705 N/cm for armored cables and 600 N/cm for non-armored cables. There shall be no attenuation increase after force is removed.

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4. Cable Structure:

   a. Number of Fibers: Supply the required number of fibers in each cable for DDC system indicated, plus not less than 50 percent spare. Cable structure shall have fibers grouped for easy handling.
   b. Strength Members: Include cable with strength members to satisfy mechanical and environmental conditions indicated.
   c. Cable Core: Core shall consist of stranded buffer tubes around a central member of appropriate geometric size and shall be filled and bound to maintain core integrity. A fibrous strength member may be stranded around core to provide necessary strength for cable.
   d. Cable Jacket: Protect cable by an extruded-polyethylene jacket.
   e. Cable Armor: For cables requiring extra mechanical protection, one or two layers of galvanized corrugated steel tape coated by an anticorrosive compound shall be either helically or longitudinally applied over standard outer jacket. Apply a second outer jacket of polyethylene over coated steel tape. Thickness of sheaths and jackets are not specified as long as mechanical and environmental conditions are satisfied.
   f. Cable Installation: Cables shall be suitable for a semiprotected outdoor installation.

5. Packaging and Shipping:

   a. Seal both ends of each length of cable.
   b. Test individual fibers in each cable before shipping to verify compliance with Specifications.

B. Connectors:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMP NETCONNECT; a Tyco Electronics brand, a TE Connectivity Ltd. company.
   b. AT&T.
   c. Communications Specialties, Inc.
   d. Corning Cable Systems.
   e. Current Technology Inc.
   f. Data Base Access Systems, Inc.
   g. EOTec; a brand of Ultra Electronics, Nuclear Sensors & Process Instrumentation.
   h. Liteway, Inc.
   i. Times Fiber Communications, Inc.

2. Performance Requirements:

   a. Type: Fiber-optic connectors shall be either Type ST or Type SMA. Use either connector type exclusively. No substitutions are allowed.
   b. Insertion Loss: Connector shall have an insertion loss of not greater than 1 dB.

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c. Coupling Tolerance: Connector shall withstand at least 500 couplings with insertion loss within 0.25-dB tolerance limit.
d. Mechanical Requirements:

1) Connector shall enclose outermost coating of single fiber cable and be able to be mated or unmated without using a tool.
2) Mount connector rigidly in a metal frame.
3) Connector shall allow a semiskilled person to properly install connector to a single fiber easily in a field environment with simple tools.

C. Splice Organizer Cabinet:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M.
b. ADC.
c. AMP NETCONNECT; a Tyco Electronics brand, a TE Connectivity Ltd. company.
d. Communications Specialties, Inc.
e. Corning Cable Systems.
f. Liteway, Inc.

2. Minimum Capacity: Each splice organizer shall accommodate number of connectors required for DDC system indicated, plus 100 percent spare.
3. Mounting: Wall mount the splice organizer cabinet.

D. Raceways:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anixterl Inc.
b. Condux International, Inc.
c. Dura-Line.
d. Pacific Plastics, Inc.

2. Mechanical and Performance Requirements:

a. Construction: Nonmetallic, flexible raceway system manufactured specifically for routing fiber-optic cables.
b. Suitable for use in return-air plenums, air-handling rooms, above ceilings and under access floors.
c. Exhibit low smoke generation and flame-spread characteristics, and have high-temperature service tolerance.
d. Size raceway according to NFPA 70 requirements for communications cables.
e. Tensile Strength at Yield: 10,800 psi.
f. Elongation at Break: 25 percent.

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E. Cable Identification:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mueller Industries, Inc.'s "Streamline" or comparable product by one of the following:

2. Labeling product shall be self-laminating cable marker.
3. Cable labeling shall include numeric designation, source, destination, and cable type.

2.27 ACCESSORIES

A. Pressure Electric Switches:

1. Diaphragm-operated snap acting switch.
2. Set point adjustable from 3 to 20 psig (21 to 138 kPa).
3. Differential adjustable from 2 to 6 psig (14 to 41 kPa).
4. Rated for resistance loads at 120-V ac.
5. Body and switch housing shall be metal.

B. Manual Valves:

1. Ball Type:

a. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO INC.'s "T-580-70-66" or comparable product by one of the following:

b. Body: Bronze ASTM B 62 or ASTM B 61.
c. Ball: Type 316 stainless steel.
d. Stem: Type 316 stainless steel.
e. Seats: Reinforced PTFE.
f. Packing Ring: Reinforced PTFE.
g. Lever: Stainless steel with a vinyl grip.
h. 600 WOG.
i. Threaded end connections.

C. Wall-Mounted Portable Operator's Workstation Cabinet:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Lowell Manufacturing Company's "Model L83-5S" or comparable product by one of following:

2. Surface-mounted wall cabinet for tilt-out operation of laptop computers and PDAs.
3. Cabinet shall have a load limit of 50 lb (23 kg).
4. Cabinet shall include the following:

a. Oil-filled dampers for controlled lowering of equipment to operational position.
b. 3RU EIA mounting rails.

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c. Removable laptop shelf.
d. Separate top compartment with mounting area, hinged rail, and security lock.
e. Front ventilation slots.
f. Knockouts for conduit connections on top and bottom of cabinet.

5. Cabinet shall be constructed of steel and painted with a powder-coat epoxy.
6. Inside center of backbox shall have provision to mount a field-furnished and -installed, single gang electrical outlet box.

2.28 IDENTIFICATION

A. Instrument Air Pipe and Tubing:

1. Engraved tag shall bear the following information:

a. Service (Example): "Instrument Air."
b. Pressure Range (Example): 0 to 30 psig (0 to 200 kPa).

2. Letter size shall be a minimum of 0.25 inch (6 mm) high.
3. Tag shall consist of white lettering on blue background.
4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded blue with contrasting white center exposed by engraving through outer layer.
5. Include tag with a brass grommet, chain, and S-hook.

B. Control Equipment, Instruments, and Control Devices:

1. Engraved tag bearing unique identification.

a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.

2. Letter size shall be as follows:

a. Operator Workstations: Minimum of 0.5 inch (13 mm) high.
b. Servers: Minimum of 0.5 inch (13 mm) high.
c. Printers: Minimum of 0.5 inch (13 mm) high.
d. DDC Controllers: Minimum of 0.5 inch (13 mm) high.
e. Gateways: Minimum of 0.5 inch (13 mm) high.
f. Repeaters: Minimum of 0.5 inch (13 mm) high.
g. Enclosures: Minimum of 0.5 inch (13 mm) high.
h. Electrical Power Devices: Minimum of 0.25 inch (6 mm) high.
i. UPS units: Minimum of 0.5 inch (13 mm) high.
j. Accessories: Minimum of 0.25 inch (6 mm) high.
k. Instruments: Minimum of 0.25 inch (6 mm) high.
l. Control Damper and Valve Actuators: Minimum of 0.25 inch (6 mm) high.

3. Tag shall consist of white lettering on black background.

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4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer.
5. Tag shall be fastened with drive pins.
6. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

C. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tags shall be at least 1.5 inches (38 mm) in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

D. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.
3. For raceways housing pneumatic tubing, add a phenolic tag labeled "HVAC Instrument Air Tubing."
4. For raceways housing air signal tubing, add a phenolic tag labeled "HVAC Air Signal Tubing."

E. Equipment Warning Labels:

1. Acrylic label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size shall be at least 14-point type with white lettering on red background.
3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least 0.25 inch (6 mm)beyond white border.

2.29 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to evaluate the following according to industry standards for each product, and to verify DDC system reliability specified in performance requirements:

1. DDC controllers.

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2. Gateways.
3. Routers.
4. Operator workstations.

B. Product(s) and material(s) will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for products to verify actual locations of connections before installation.

1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:

1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
2. Equipment to Be Connected:
   a. Chillers specified in Section 236423 "Scroll Water Chillers."

   b. Variable-frequency controllers specified in Section 262923 "Variable-Frequency Motor Controllers."

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3.3 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS

A. Interface with Existing Systems:

1. DDC systems shall interface existing systems to achieve integration.
2. Monitoring and Control of DDC System by Existing Control System:

    a. DDC system performance requirements shall be satisfied when monitoring and controlling DDC system by existing control system.
    b. Operator of existing system shall be able to upload, download, monitor, trend, control, and program every input and output point in DDC system from existing control system using existing control system software and operator workstations.
    c. Remote monitoring and control from existing control system shall not require operators of existing control system to learn new software.
    d. Interface of DDC system into existing control system shall be transparent to operators of existing control system and allow operators to program, monitor, and control DDC system from any operator workstation connected to existing control system.

3. Integration of Existing Control System into DDC System:

    a. Existing control system performance requirements shall be satisfied when monitoring and controlling existing control system through DDC system.
    b. Operator shall be able to upload, download, monitor, alarm, report, trend, control, and program every input and output point in existing system from DDC system using operator workstations and software provided. The combined systems shall share one database.
    c. Interface of existing control system I/O points into DDC system shall be transparent to operators. All operational capabilities shall be identical regardless of whether I/O already exists or I/O is being installed.

B. Integration with Existing Enterprise System:

1. DDC system shall interface with an existing enterprise system to adhere to Owner standards already in-place and to achieve integration.
2. Owner's control system integrator will provide the following services:

    a. Enterprise system expansion and development of graphics, logs, reports, trends, and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
    b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.
    c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.

3. Engage Owner's control system integrator to provide the following services:

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a. Enterprise system expansion and development of graphics, logs, reports, trends and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.
c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.

4. Attend meetings with control system integrator to integrate DDC system.

3.4 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.
1. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."
2. .

C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. DDC control valves, which are specified in Section 230923.11 "Control Valves."
2. Pipe-mounted flow meters, which are specified in Section 230923.14 "Flow Instruments."
3. Pipe-mounted sensors, switches, and transmitters. Flow meters are specified in Section **230923**.14 "Flow Instruments." Liquid temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
4. Tank-mounted sensors, switches, and transmitters. Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments." Liquid temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
5. Pipe- and tank-mounted thermowells. Liquid thermowells are specified in Section 230923.27 "Temperature Instruments."

3.5 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

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C. Support products, tubing, piping wiring, and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to a5 pound force.

D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Firestop penetrations made in fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."

H. Welding Requirements:

1. Restrict welding and burning to supports and bracing.
2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

I. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

K. Corrosive Environments:

1. Avoid or limit use of materials in corrosive airstreams and environments, including, but not limited to, the following:

   a. Laboratory exhaust-air streams.
   b. Process exhaust-air streams.

2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with

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a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.6 POT INSTALLATION

A. Install one portable operator terminal(s).

B. Turn over POTs to Owner at Substantial Completion.

C. Install software on each POT and verify that software functions properly.

3.7 GATEWAY INSTALLATION

A. Install gateways if required for DDC system communication interface requirements indicated.

1. Install gateway(s) required to suit indicated requirements.

B. Test gateway to verify that communication interface functions properly.

3.8 ROUTER INSTALLATION

A. Install routers if required for DDC system communication interface requirements indicated.

1. Install router(s) required to suit indicated requirements.

B. Test router to verify that communication interface functions properly.

3.9 CONTROLLER INSTALLATION

A. Install controllers in enclosures to comply with indicated requirements.

B. Connect controllers to field power supply and to UPS units where indicated.

C. Install controller with latest version of applicable software and configure to execute requirements indicated.

D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.

E. Installation of Network Controllers:

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1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Top of controller shall be within 72 inches (1800 mm) of finished floor.

F. Installation of Programmable Application Controllers:

1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Top of controller shall be within 72 inches (1800 mm) of finished floor.

G. Application-Specific Controllers:

1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

3.10 INSTALLATION OF WIRELESS ROUTERS FOR OPERATOR INTERFACE

A. Install wireless routers to achieve optimum performance and best possible coverage.

B. Mount wireless routers in a protected location that is within 60 inches (1500 mm) of floor and easily accessible by operators.

C. Connect wireless routers to field power supply and to UPS units if network controllers are powered through UPS units.

D. Install wireless router with latest version of applicable software and configure wireless router with WPA2 security and password protection. Create access password with not less than 12 characters consisting of letters and numbers and at least one special character. Document password in operations and maintenance manuals for reference by operators.

E. Test and adjust wireless routers for proper operation with portable workstation and other wireless devices intended for use by operators.

3.11 ENCLOSURES INSTALLATION

A. Install the following items in enclosures, to comply with indicated requirements:

1. Gateways.
2. Routers.
3. Controllers.
4. Electrical power devices.
5. UPS units.
6. Relays.
7. Accessories.

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8. Instruments.
9. Actuators

B. Attach wall-mounted enclosures to wall using the following types of steel struts:

1. For NEMA 250, Type 1 Enclosures: Use painted steel strut and hardware.
2. For NEMA 250, Type 4 Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align top of adjacent enclosures of like size.

D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete housekeeping pads. Attach enclosure legs using galvanized- or stainless-steel anchors.

E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireway used for application shall have protection equal to NEMA 250 rating of connected enclosures.

3.12 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

3.13 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.

B. Install engraved phenolic nameplate with unique identification on face for each of the following:

1. Operator workstation.
2. Server.

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3. Printer.
4. Gateway.
5. Router.
6. Protocol analyzer.
7. DDC controller.
8. Enclosure.
9. Electrical power device.
10. UPS unit.
11. Accessory.

C. Install engraved phenolic nameplate with unique instrument identification on face of each instrument connected to a DDC controller.

D. Install engraved phenolic nameplate with identification on face of each control valve actuator connected to a DDC controller.

E. Where product is installed above accessible tile ceiling, also install matching engraved phenolic nameplate with identification on face of ceiling grid located directly below.

F. Where product is installed above an inaccessible ceiling, also install engraved phenolic nameplate with identification on face of access door directly below.

G. Warning Labels:

1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
2. Shall be located in highly visible location near power service entry points.

3.14 NETWORK INSTALLATION

A. Install fiber-optic cable when connecting between the following network devices and when located in different buildings on campus, or when distance between devices exceeds300 ft.:

1. Operator workstations.
2. Operator workstations and network controllers.
3. Network controllers.
4. .

B. Install copper or fiber-optic cable when connecting between the following network devices located in same building:

1. Operator workstations.
2. Operator workstations and network controllers.
3. Network controllers.
4. .

C. Install copper cable when connecting between the following:

1. Gateways.

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2. Gateways and network controllers or programmable application controllers.
3. Routers.
4. Routers and network controllers or programmable application controllers.
5. Network controllers and programmable application controllers.
6. Programmable application controllers.
7. Programmable application controllers and application-specific controllers.
8. Application-specific controllers.
9. .

D. Install network cable in continuous raceway.

1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

3.15 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

B. ASHRAE 135 Networks:

1. MAC Address:

a. Every network device shall have an assigned and documented MAC address unique to its network.
b. Ethernet Networks: Document MAC address assigned at its creation.
c. ARCNET or MS/TP networks: Assign from 00 to 64.

2. Network Numbering:

a. Assign unique numbers to each new network.
b. Provide ability for changing network number through device switches or operator interface.
c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.

3. Device Object Identifier Property Number:

a. Assign unique device object identifier property numbers or device instances for each device network.
b. Provide for future modification of device instance number by device switches or operator interface.
c. LAN shall support up to 4,194,302 unique devices.

4. Device Object Name Property Text:

a. Device object name property field shall support 32 minimum printable characters.
b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.

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1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".

5. Object Name Property Text for Other Than Device Objects:

a. Object name property field shall support 32 minimum printable characters.
b. Assign object name properties with plain-English names descriptive of application.

1) Example 1: "Zone 1 Temperature."
2) Example 2 "Fan Start and Stop."

6. Object Identifier Property Number for Other Than Device Objects:

a. Assign object identifier property numbers according to Drawings or tables indicated.
b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

3.16 CONTROL WIRE, CABLE, AND RACEWAYS INSTALLATION

A. Comply with NECA 1.

B. Comply with TIA 568-C.1.

C. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.
1. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

E. Field Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

F. Conduit Installation:

1. Install conduit expansion joints where conduit runs exceed 200 feet (60 m), and conduit crosses building expansion joints.
2. Coordinate conduit routing with other trades to avoid conflicts with ducts, pipes and equipment and service clearance.
3. Maintain at least 3-inch (75-mm) separation where conduits run axially above or below ducts and pipes.

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4. Limit above-grade conduit runs to 100 feet (30 m) without pull or junction box.
5. Do not install raceways or electrical items on any "explosion-relief" walls, or rotating equipment.
6. Do not fasten conduits onto the bottom side of a metal deck roof.
7. Flexible conduit is permitted only where flexibility and vibration control is required.
8. Limit flexible conduit to 3 feet (1 m) long.
9. Conduit shall be continuous from outlet to outlet, from outlet to enclosures, pull and junction boxes, and shall be secured to boxes in such manner that each system shall be electrically continuous throughout.
10. Direct bury conduits underground or install in concrete-encased duct bank where indicated.

    a. Use rigid, nonmetallic, Schedule 80 PVC.
    b. Provide a burial depth according to NFPA 70, but not less than 24 inches (600 mm).

11. Secure threaded conduit entering an instrument enclosure, cabinet, box, and trough, with a locknut on outside and inside, such that conduit system is electrically continuous throughout. Provide a metal bushing on inside with insulated throats. Locknuts shall be the type designed to bite into the metal or, on inside of enclosure, shall have a grounding wedge lug under locknut.
12. Conduit box-type connectors for conduit entering enclosures shall have an insulated throat.
13. Connect conduit entering enclosures in wet locations with box-type connectors or with watertight sealing locknuts or other fittings.
14. Offset conduits where entering surface-mounted equipment.
15. Seal conduit runs used by sealing fittings to prevent the circulation of air for the following:

    a. Conduit extending from interior to exterior of building.
    b. Conduit extending into pressurized duct and equipment.
    c. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
    d. .

G. Wire and Cable Installation:

1. Cables serving a common system may be grouped in a common raceway. Install control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.

    a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.

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3. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
5. UTP Cable Installation:

    a. Comply with TIA 568-C.2.
    b. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination, to maintain cable geometry.

6. Installation of Cable Routed Exposed under Raised Floors:

    a. Install plenum-rated cable only.
    b. Install cabling after the flooring system has been installed in raised floor areas.
    c. Coil cable 6 feet (1.8 m) long not less than 12 inches (300 mm) in diameter below each feed point.

7. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.
8. Provide strain relief.
9. Terminate wiring in a junction box.

    a. Clamp cable over jacket in junction box.
    b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.

10. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
11. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
12. Keep runs short. Allow extra length for connecting to terminal boards. Do not bend flexible coaxial cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
13. Ground wire shall be copper and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
14. Wire and cable shall be continuous from terminal to terminal without splices.
15. Use insulated spade lugs for wire and cable connection to screw terminals.
16. Use shielded cable to transmitters.
17. Use shielded cable to temperature sensors.
18. Perform continuity and meager testing on wire and cable after installation.
19. Do not install bruised, kinked, scored, deformed, or abraded wire and cable. Remove and discard wire and cable if damaged during installation, and replace it with new cable.
20. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

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21. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
22. Protection from Electro-Magnetic Interference (EMI): Provide installation free of (EMI). As a minimum, comply with the following requirements:

    a. Comply with BICSI TDMM and TIA 569-C for separating unshielded cable from potential EMI sources, including electrical power lines and equipment.
    b. Separation between open cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

        1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
        2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
        3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).

    c. Separation between cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

        1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
        2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
        3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

    d. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

        1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
        2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
        3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

    e. Separation between Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).
    f. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.17 FIBER-OPTIC CABLE SYSTEM INSTALLATION

A. Comply with TIA 568-C.3, except where requirements indicated are more stringent.

B. Raceway Installation:

1. Install continuous raceway for routing fiber-optic cables.

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2. Install raceways continuously between pull boxes and junction boxes. Raceways shall enter and be secured to enclosures.
3. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
4. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Use long radius elbows for all fiber-optic cables.
5. Entire raceway shall be complete and raceway interior cleaned before installation of fiber-optic cables.
6. Securely fasten raceway to building structure using clamps and clips designed for purpose.
7. Install nylon or polyethylene pulling line in raceways. Clearly label as "pulling line," indicating source and destination.

C. Fiber-Optic Cable Installation:

1. Route cables as efficiently as possible, minimizing amount of cable required.
2. Continuously lubricate cables during pulling-in process.
3. Do not exceed maximum pulling tensions provided by cable manufacturer. Monitor cable pulling tension with a mechanical tension meter.
4. Arrange cables passing through pull boxes to obtain maximum clearance among cables within box.
5. As cables emerge from intermediate point pull boxes, coil cable in a figure eight pattern with loops not less than 24 inches (600 mm) in diameter.
6. Terminate fiber-optic cables in a fiber-optic splice organizer cabinet, unless connected equipment can accept fiber-optic cables directly. Terminate cables with connectors.
7. Install and connect appropriate opto-electronic equipment and fiber jumper cables between opto-electronic equipment and fiber-optic cable system to DDC system fiber-optic cable system. Verify interface compatibility.

D. Cable and Raceway Identification:

1. Label cables at both ends. Labels shall be typed, not handwritten.
2. Mark raceways at each pull box indicating the type and number of cables within.

3.18 FIELD QUALITY CONTROL

A. Testing Agency: Owner will 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 installations, including connections.

C. Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Testing of Pneumatic and Air-Signal Tubing:

    a. Test for leaks and obstructions.
    b. Disconnect each pipe and tubing line before a test is performed, and blowout dust, dirt, trash, condensate, and other foreign materials with compressed air. Use commercially pure compressed air or nitrogen as distributed in gas cylinders. Air from an oil-free compressor with an air dryer is an acceptable alternative for the test.
    c. After foreign matter is expelled and line is free from obstructions, plug far end of tubing run.
    d. Connect a pressure source to near end of run with a needle valve between air supply and tubing run.
    e. Connect a pressure gage accurate to within 0.5 percent of test between the shutoff needle valve and tubing run under test.
    f. For system pressures above 30 psig (207 kPa), apply a pressure of 1.5 times operating pressure. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 1 psig (6.9 kPa).
    g. For system pressures 30 psig (207 kPa) and below, apply a pressure of 2.0 times operating pressure to piping and tubing run. Record pressure in tubing run every 5 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 0.5 psig (3.5 kPa).

D. Testing:

1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.
3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use a fiber-optic time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

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3.19 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

E. For pneumatic products, verify that air supply for each product is properly installed.

F. Control Damper Checkout:

1. For pneumatic dampers, verify that pressure gages are provided in each air line to damper actuator and positioner.
2. Verify that control dampers are installed correctly for flow direction.
3. Verify that proper blade alignment, either parallel or opposed, has been provided.
4. Verify that damper frame attachment is properly secured and sealed.
5. Verify that damper actuator and linkage attachment is secure.
6. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
7. Verify that damper blade travel is unobstructed.

G. Control Valve Checkout:

1. For pneumatic valves, verify that pressure gages are provided in each air line to valve actuator and positioner.
2. Verify that control valves are installed correctly for flow direction.
3. Verify that valve body attachment is properly secured and sealed.
4. Verify that valve actuator and linkage attachment is secure.
5. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
6. Verify that valve ball, disc or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

H. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.

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6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments:

    a. Verify sensing element type and proper material.
    b. Verify length and insertion.

3.20 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.

G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.

H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.

I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

J. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

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K. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

L. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.21 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase, and hertz.
2. Verify that protection from power surges is installed and functioning.

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3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.22 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.
4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:

    a. Upper quarter of range.
    b. Lower quarter of range.
    c. At midpoint of range.

8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.23 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

B. After approval of Test Plan, execute all tests and procedures indicated in plan.

C. After testing is complete, submit completed test checklist.

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D. Pretest Checklist: Submit the following list with items checked off once verified:

1. Detailed explanation for any items that are not completed or verified.
2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
3. HVAC equipment motors operate below full-load amperage ratings.
4. Required DDC system components, wiring, and accessories are installed.
5. Installed DDC system architecture matches approved Drawings.
6. Control electric power circuits operate at proper voltage and are free from faults.
7. Required surge protection is installed.
8. DDC system network communications function properly, including uploading and downloading programming changes.
9. Using BACnet protocol analyzer, verify that communications are error free.
10. Each controller's programming is backed up.
11. Equipment, products, tubing, wiring cable, and conduits are properly labeled.
12. All I/O points are programmed into controllers.
13. Testing, adjusting, and balancing work affecting controls is complete.
14. Dampers and actuators zero and span adjustments are set properly.
15. Each control damper and actuator goes to failed position on loss of power.
16. Valves and actuators zero and span adjustments are set properly.
17. Each control valve and actuator goes to failed position on loss of power.
18. Meter, sensor, and transmitter readings are accurate and calibrated.
19. Control loops are tuned for smooth and stable operation.
20. View trend data where applicable.
21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
26. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 20 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.

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a. Verify analog I/O points at operating value.
b. Adjust out-of-tolerance I/O points.

1) Identify I/O points for future reference.
2) Simulate abnormal conditions to demonstrate proper function of safety devices.
3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.

2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:

a. Re-check I/O points that required corrections during initial test.
b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.

5. After 24 Hours of Second Validation Test:

a. Re-check I/O points that required corrections during second test.
b. Continue validation testing until I/O point is normal on two consecutive tests.

6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.

a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.

2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate DDC system, as follows:

a. Reaction to COV and alarm conditions during HLC.
b. Ability to update DDC system database during HLC.

5. Passing test is contingent on the following:

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a. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
b. All alarms, both binary and analog, are reported and printed; none are lost.
c. Compliance with response times specified.

6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

3.24 DDC SYSTEM WIRELESS NETWORK VERIFICATION

A. DDC system Installer shall design wireless DDC system networks to comply with performance requirements indicated.

B. Installer shall verify wireless network performance through field testing and shall document results in a field test report.

C. Testing and verification of all wireless devices shall include, but not be limited to, the following:

1. Speed.
2. Online status.
3. Signal strength.

3.25 FINAL REVIEW

A. Submit written request to Architect and Construction Manager when DDC system is ready for final review. Written request shall state the following:

1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.

B. Review by Architect and Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

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C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.

E. Prepare and submit closeout submittals and begin procedures indicated in "Extended Operation Test" Article when no deficiencies are reported.

F. A part of DDC system final review shall include a demonstration to parties participating in final review.

1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
3. Demonstration shall include, but not be limited to, the following:

    a. Accuracy and calibration of 20 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
    b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 20 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
    c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
    d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
    e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
    f. Trends, summaries, logs, and reports set-up for Project.
    g. For up to three HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
    h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
    i. Software's ability to edit control programs off-line.

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j. Data entry to show Project-specific customizing capability including parameter changes.
k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
l. Execution of digital and analog commands in graphic mode.
m. Spreadsheet and curve plot software and its integration with database.
n. Online user guide and help functions.
o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
p. System speed of response compared to requirements indicated.
q. For Each Network and Programmable Application Controller:

1) Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
2) Operator Interface: Ability to connect directly to each type of digital controller with a portable operator workstation and PDA. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
4) Electric Power: Ability to disconnect any controller safely from its power source.
5) Wiring Labels: Match control drawings.
6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

r. For Each Operator Workstation:

1) I/O points lists agree with naming conventions.
2) Graphics are complete.
3) UPS unit, if applicable, operates.

s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability. Requirements must be met even if only one manufacturer's equipment is installed.

1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated. Modifications are made with messages and write services initiated by an operator using

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workstation graphics, or by completing a field in a menu with instructional text.

4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
10) Device and Network Management:

    a) Display of network device status.
    b) Display of BACnet Object Information.
    c) Silencing devices transmitting erroneous data.
    d) Time synchronization.
    e) Remote device re-initialization.
    f) Backup and restore network device programming and master database(s).
    g) Configuration management of routers.

t. .

3.26 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.27 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by DDC system manufacturer's authorized service representative. Include monthly preventive maintenance, repair, or replacement of worn or defective components, cleaning, calibration, and adjusting as required for

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proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.28 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two year(s).

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two year(s) from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.29 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.

B. Extent of Training:

1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:

    a. Provide not less than five days of training total.
    b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
    c. Total days of training shall be broken into not more than two separate training classes.
    d. Each training class shall be not less than one consecutive day(s).

C. Training Schedule:

1. Schedule training with Owner 20 business days before expected Substantial Completion.
2. Schedule training to provide Owner with at least 20 business days of notice in advance of training.
3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with 15-minute

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break between sessions. Morning and afternoon sessions shall be separated by 60-minute lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.

4. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number, and e-mail address.
2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.

E. Training Attendee Headcount:

1. Plan in advance of training for five attendees.
2. Make allowance for Owner to add up to two attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:
1. Intermediate user knowledge of computers and office applications.
2. Intermediate knowledge of HVAC systems.
3. Intermediate knowledge of DDC systems.
4. Intermediate knowledge of DDC system and products installed.

G. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

H. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.

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2. Instructors shall have not less than five years of providing instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.

I. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:

   a. Daily operators.
   b. Advanced operators.
   c. System managers and administrators.

2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.

J. Training Outline:

1. Submit training outline for Owner review at least 10 business day before scheduling training.
2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.

K. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

L. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm, and each unique optimization routine.

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5. Operating operator workstations, printers, and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports, and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:

    a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers, and valves for correct position under each condition.
    b. For HVAC equipment with factory-installed software, show that integration into DDC system can communicate with DDC controllers or gateways, as applicable.
    c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
    d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
    e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.

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f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

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M. Training Content for Advanced Operators:

1. Making and changing workstation graphics.
2. Creating, deleting, and modifying alarms including annunciation and routing.
3. Creating, deleting, and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting, and modifying reports.
5. Creating, deleting, and modifying points.
6. Creating, deleting, and modifying programming including ability to edit control programs off-line.
7. Creating, deleting, and modifying system graphics and other types of displays.
8. Adding DDC controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing DDC system checkout and diagnostic procedures.
11. Performing DDC controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring DDC system hardware including controllers, workstations, communication devices, and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing, and repairing hardware.
15. Adjusting, calibrating, and replacing DDC system components.

N. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading, and off-line archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

O. Video of Training Sessions:

1. Provide a digital video and audio recording of each training session. Create a separate recording file for each session.
2. Stamp each recording file with training session number, session name, and date.
3. Provide Owner with two copies of digital files on DVDs or flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

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END OF SECTION 230923

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SECTION 230923.11 - CONTROL VALVES

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 control valves and actuators for DDC systems.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section **230923.11**.

1.3 DEFINITIONS

A. Cv: Design valve coefficient.

B. DDC: Direct-digital control.

C. NBR: Nitrile butadiene rubber.

D. PTFE: Polytetrafluoroethylene

E. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient

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operating environment, including temperature and humidity.

3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for pneumatic signal and main air tubing.

C. Delegated-Design Submittal:

1. Schedule and design calculations for control valves and actuators, including the following:

    a. Flow at project design and minimum flow conditions.
    b. Pressure differential drop across valve at project design flow condition.
    c. Maximum system pressure differential drop (pump close-off pressure) across valve at project minimum flow condition.
    d. Design and minimum control valve coefficient with corresponding valve position.
    e. Maximum close-off pressure.
    f. Leakage flow at maximum system pressure differential.
    g. Torque required at worst case condition for sizing actuator.
    h. Actuator selection indicating torque provided.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Control valve installation location shown in relationship to room, duct, pipe, and equipment.
2. Size and location of wall access panels for control valves installed behind walls.
3. Size and location of ceiling access panels for control valves installed above inaccessible ceilings.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control valves to include in operation and maintenance manuals.

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PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.

D. Ground Fault: Products shall not fail due to ground fault condition when suitably grounded.

E. Backup Power Source: Systems and equipment served by a backup power source shall have associated control valve actuators served from a backup power source.

F. Environmental Conditions:

1. Provide electric control valve actuators, with protective enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Electric control valve actuators not available with integral enclosures, complying with requirements indicated, shall be housed in protective secondary enclosures.

    a. Hazardous Locations: Explosion-proof rating for condition.

G. Determine control valve sizes and flow coefficients by ISA 75.01.01.

H. Control valve characteristics and rangeability shall comply with ISA 75.11.01.

I. Selection Criteria:

1. Control valves shall be suitable for operation at following conditions:

    a. Chilled Water: <**Insert pressure and coincident temperature requirements**>.
    b. Condenser Water: <**Insert pressure and coincident temperature requirements**>.
    c. Heating Hot Water: <**Insert pressure and coincident temperature requirements**>.

2. Control valve shutoff classifications shall be FCI 70-2, Class IV or better unless otherwise indicated.
3. Valve pattern, three-way or straight through, shall be as indicated on Drawings.
4. Modulating straight-through pattern control valves shall have equal percentage flow-throttling characteristics unless otherwise indicated.

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5. Modulating three-way pattern water valves shall have linear flow-throttling characteristics. The total flow through the valve shall remain constant regardless of the valve's position.
6. Modulating butterfly valves shall have linear or equal percentage flow-throttling characteristics.
7. Fail positions unless otherwise indicated:

    a. Chilled Water: Last position.
    b. Condenser Water: Last position.
    c. Heating Hot Water: Last position.

8. Globe-type control valves shall pass the design flow required with not more than 95 percent of stem lift unless otherwise indicated.
9. Rotary-type control valves, such as ball and butterfly valves, shall have Cv falling between 65 and 75 degrees of valve full open position and minimum valve Cv between 15 and 25 percent of open position.
10. Selection shall consider viscosity, flashing, and cavitation corrections.
11. Valves shall have stable operation throughout full range of operation, from design to minimum Cv.
12. Minimum Cv shall be calculated at 20 percent of design flow, with a coincident pressure differential equal to the system design pump head.
13. In water systems, select modulating control valves at terminal equipment for a design Cv based on a pressure drop of 5 psig at design flow unless otherwise indicated.

14. Two-position control valves shall be line size unless otherwise indicated.

2.2 BUTTERFLY-STYLE CONTROL VALVES

A. Industrial-Grade Butterfly Valves:

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Fisher Valves & Instruments, Emerson Electric Co.; 8532 and 8580 series.
    b. Jamesbury valves.

2. Performance:

    a. Process Temperature Rating: Minus 200 to plus 849 deg F .
    b. ASME B16.34, Class 150 for larger sizes.
    c. Complies with MSS SP-68.
    d. Leakage: FCI 70-2, Class VI, bi-directional.
    e. Rangeability: 100 to 1.
    f. Rotation: Zero to 90 degrees.
    g. Linear or modified equal percentage flow characteristic.

3. Body: Cast steel ASTM A 216/A 216M WCB, fully lugged, suitable for mating to ASME B16.5 flanges.
4. Disc: ASTM A 351/A 351M, CF3M or CF8M stainless steel.

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5. Shaft: 17-4 PH stainless steel.
6. Seat: Reinforced PTFE with retaining ring.
7. Shaft Bushings: Reinforced PTFE or stainless steel.
8. Replaceable seat, disc, and shaft bushings.
9. Corrosion-resistant nameplate indicating:

    a. Manufacturer's name, model number, and serial number.
    b. Body size.
    c. Body and trim materials.
    d. Body rating.
    e. Arrow indicating direction of flow.

2.3 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Actuators for Hydronic Control Valves: Capable of closing valve against system pump shutoff head.

B. Position indicator and graduated scale on each actuator.

C. Type: Motor operated, with or without gears, electric and electronic.

D. Voltage: 24-V ac.

E. Deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.

F. Function properly within a range of 85 to 120 percent of nameplate voltage.

G. Construction:

1. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.
3. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

H. Field Adjustment:

1. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.
2. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

I. Two-Position Actuators: Single direction, spring return or reversing type.

J. Modulating Actuators:

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1. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.
2. Control Input Signal:
   a. Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10- or 2- to 10-V dc and 4- to 20-mA signals.
   b. Programmable Multi-Function:

      1) Control Input, Position Feedback, and Running Time: Factory or field programmable.
      2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
      3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

K. Position Feedback:

1. Equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.
2. .

L. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other non-mechanical forms of fail-safe operation are acceptable only where uniquely indicated.

M. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

N. Valve Attachment:

1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve shaft without the need for connecting linkages.
2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

O. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F .
2. Humidity: Suitable for humidity range encountered by application; minimum

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operating range shall be from 5 to 95 percent relative humidity, non-condensing.

P. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 2 for indoor and protected applications.
3. NEMA 250, Type 4 or Type 4X for outdoor and unprotected applications.
4. Provide actuator enclosure with heater and control where required by application.

Q. Stroke Time:

1. Operate valve from fully closed to fully open within 60 seconds.
2. Operate valve from fully open to fully closed within 60 seconds.
3. All motorized valves to fail in state.
4. Select operating speed to be compatible with equipment and system operation.

R. Sound:
1. Non-Spring Return: 45 dBA.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL VALVE APPLICATIONS

A. Control Valves:

1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
2. Chilled water System, , Two-Way Applications Controlled by Flow: Butterfly-style valves, industrial-grade valves.
3. Heating water System,,Two-Way Applications Controlled by Pressure: Butterfly-style valves, industrial-grade valves.
4. Condenser water System,, Two-Way Applications Controlled by Temperature: Butterfly-style valves, industrial-grade valves.

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3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a 5 pound force.

D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Firestop penetrations made in fire-rated assemblies and seal penetrations made in acoustically rated assemblies.

F. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

H. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including. but not limited to, the following:

    a. Laboratory exhaust airstreams.
    b. Process exhaust airstreams.

3. Use Type 316 stainless-steel tubing and fittings when in contact with a corrosive environment.
4. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
5. Where control devices are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

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3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.5 CONTROL VALVES

A. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold and for each control valve larger than NPS 2 .

D. Install pressure temperature taps in piping upstream and downstream of each control valve larger than NPS 2 .

E. Valve Orientation:

1. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.
2. Install valves in a position to allow full stem movement.
3. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

F. Clearance:

1. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

G. Flanged Valves:

1. Align flange surfaces parallel.
2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

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3.6 CONNECTIONS

A. Connect electrical devices and components to electrical grounding system. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.9 CHECKOUT PROCEDURES

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Verify that control valves are installed correctly for flow direction.
5. Verify that valve body attachment is properly secured and sealed.
6. Verify that valve actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that valve ball, disc, and plug travel are unobstructed.
9. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

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C. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION **230923.11**

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SECTION 230923.14 - FLOW INSTRUMENTS

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. Liquid flow transmitters.

B. Related Requirements:

   1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section **230923.14**.

1.3 DEFINITIONS

A. Ethernet: Local area network based on IEEE 802.3 standards.

B. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

C. PEEK: polyetheretherketone.

D. PTFE: Polytetrafluoroethylene.

E. PPS: Polyphenylene sulfide.

F. RS-485: A TIA standard for multipoint communications using two twisted pairs.

G. RTD: Resistance temperature detector.

H. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

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1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for air and process signal tubing.
5. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each product requiring a certificate.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Provide parts, as indicated by manufacturer's recommended parts list, for product operation during one-year period following warranty period.

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PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 GENERAL REQUIREMENTS FOR FLOW INSTRUMENTS

A. Liquid and steam sensors, meters, and transmitters shall have an extended range of 20 percent above Project design flow and 10 percent below Project minimum flow to signal abnormal flow conditions and to provide flexibility for changes in operation.

B. All devices shall have a BACnet MSTP fieldbus interface.

2.3 LIQUID FLOW METERS

A. General Requirements for Liquid Flow Meters:

1. Adjustable for changes in system operational parameters.
2. Liquid and Steam Sensors, Meters, and Transmitters: Extended range of 10 percent above Project design flow and 10 percent below Project minimum flow to signal abnormal flow conditions.
3. Manufacturer shall certify that each flow instrument indicated complies with specified performance requirements and characteristics.
4. Product certificates are required.

B. In-line Body Electromagnetic Flow Meter:

1. Products: Subject to compliance with requirements, [**provide the following**] [**provide one of the following**] [**available products that may be incorporated into the Work include, but are not limited to, the following**]:

   a. Onicon Incorporated; F-3200 Series.
   b. Rosemount 8700 Series.

2. Description:

   a. No moving parts.
   b. Suitable for flow measurement of fluids with electrical conductivity more than 5 microsiemens per cm.
   c. Inherent bi-directional flow measurement.
   d. Flow measurement with three pipe diameters upstream and two pipe diameters downstream.
   e. Wet calibrate and tag meters to standards traceable to NIST, and provide each meter with a certificate of calibration.
   f. Transmitter integral to meter.

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3. Performance:

    a. Accuracy for Velocities between 3.3 and 33 fps (1 and 10 m/s): Within 0.2 percent of reading.
    b. Accuracy for Velocities between 1.0 and 3.3 fps (0.3 and 1 m/s): Within 0.75 percent of reading.
    c. Accuracy for Velocities Less than 1.0 fps ((0.3 m/s)): Within 0.0075 fps (0.0023 m/s).
    d. Ambient Temperature: Minus 4 to plus 140 deg F (Minus 20 to plus 60 deg C).
    e. Process Temperature: Minus 4 to 212 deg F (Minus 20 to plus 100 deg C).
    f. Pressure: 225 psig (1551 kPa).

4. Analog Output Current Signal:

    a. Two-wire, 4- to 20-mA dc current source.
    b. Signal capable of operating into 1000-ohm load.
    c. Isolated.

5. Digital Output Signal: Two, programmable, digital/pulse outputs configurable for frequency, pulse, or directional flow.
6. Operator Interface:

    a. Keypad.
    b. Digital Display: Multiple-line digital display of alphanumerical characters.
    c. LED for normal and alarm operation.

7. Construction:

    a. Body: Epoxy-coated carbon steel.
    b. Body Liner Material: PTFE.
    c. Flow Tube: Type 304 stainless steel.
    d. Connection: 150 Class flange.
    e. Electrodes: Type 316 stainless steel. Quantity determined by manufacturer based on application.
    f. Electronics Enclosure:

        1) Painted aluminum.
        2) Removable cover.
        3) NEMA 250, Type 4X.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of

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connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Provide the services of an independent inspection agency to confirm that proposed mounting locations comply with requirements indicated and approved submittals.

1. Indicate dimensioned locations with mounting height for all surface-mounted products to walls and ceilings on shop drawings.
2. Do not begin installation without submittal approval of mounting location.

E. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

F. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTRUMENT APPLICATIONS

A. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

B. Duct-Mounted Airflow Sensors:

1. Measured Velocities [500 fpm (2.5 m/s)] <**Insert value**> and Less: Thermal airflow station.
2. Measured Velocities Greater than [500 fpm (2.5 m/s)] <**Insert value**>: [**Pitot-tube airflow sensor station**] [**Thermal airflow station**].

C. Damper-Mounted Airflow Sensors:

1. Measured Velocities [400 fpm (2.0 m/s)] <**Insert value**> and Less: Thermal airflow station.
2. Measured Velocities Greater than [500 fpm (2.5 m/s)] <**Insert value**>: [**Pitot-tube airflow sensor station**] [**Thermal airflow station**] [**Damper with integral flow measurement**] [**Damper with integral flow control**].

D. Fan-Mounted Airflow Sensors:

1. Measured Velocities [500 fpm (2.5 m/s)] <**Insert value**> and Less: Thermal airflow station.
2. Measured Velocities Greater than [500 fpm (2.5 m/s)] <**Insert value**>: [**Pitot-tube fan inlet airflow sensor station**] [**Piezometer ring fan inlet airflow sensor**] [**Thermal airflow station**].

E. Airflow Switches:

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1. Measured Velocities 400 fpm (2.0 m/s) and Less: Polymer film sail switch.
2. Measured Velocities Greater than 400 fpm (2.0 m/s): Stainless-steel single-vane switch.

F. Airflow Transmitters for Use with Pitot-Tube-Type Sensors:

1. Exhaust Air Airflow: [**Airflow transmitter with 0.10 percent accuracy and auto-zero feature**] [**Airflow transmitter with 0.25 percent accuracy and auto-zero feature**] [**Pressure differential transmitter for airflow measurement**] [**Pressure differential indicating transmitter, switch, and controller for airflow measurement**].
2. Outdoor Air Airflow: [**Airflow transmitter with 0.10 percent accuracy and auto-zero feature**] [**Airflow transmitter with 0.25 percent accuracy and auto-zero feature**] [**Pressure differential transmitter for airflow measurement**] [**Pressure differential indicating transmitter, switch and controller for airflow measurement**].
3. Return Air Airflow: [**Airflow transmitter with 0.10 percent accuracy and auto-zero feature**] [**Airflow transmitter with 0.25 percent accuracy and auto-zero feature**] [**Pressure differential transmitter for airflow measurement**] [**Pressure differential indicating transmitter, switch, and controller for airflow measurement**].
4. Supply Air Airflow: [**Airflow transmitter with 0.10 percent accuracy and auto-zero feature**] [**Airflow transmitter with 0.25 percent accuracy and auto-zero feature**] [**Pressure differential transmitter for airflow measurement**] [**Pressure differential indicating transmitter, switch, and controller for airflow measurement**].

G. Liquid Flow Sensors (Primary Elements):

1. <**Insert system**> System, <**Insert unique application**>: [**Averaging pitot tubes**] [**Venturis**] [**Orifice plates**] [**Segmented wedge**].

H. Liquid Flow Meters:

1. <**Insert system**> System, <**Insert unique application**>: [**Insertion paddle wheel transmitter**] [**Turbine flow meter**] [**Electromagnetic flow meter**] [**Vortex shedding flow meter with integral temperature measurement**] [**Vortex shedding flow meter with integral pressure and temperature measurement**] [**Vortex shedding flow meter for hazardous environments**].

I. Liquid Flow Switches:

1. <**Insert system**> System, <**Insert unique application**>: [**Bellows type**] [**Magnetic type**].

J. Liquid Flow Transmitters:

1. <**Insert system**> System, <**Insert unique application**>: [**Pressure differential transmitter with 0.07 percent accuracy for flow measurement**] [**Liquid pressure differential transmitter**].

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3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a <**Insert value**> force.

D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:

    a. Laboratory exhaust airstreams.
    b. Process exhaust airstreams.
    c. <**Insert requirement**>.

3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

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3.5 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments in steam, liquid, and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of [**2**] [**3**] <**Insert number**> percent.
7. Install instruments in dry gas and non-condensable-vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of [**2**] [**3**] <**Insert number**> percent.

B. Mounting Height:

1. Mount instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches (1050 to)1800 mm)above the adjacent floor, grade, or service catwalk or platform.

    a. Make every effort to mount at 60 inches (1500 mm).

C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.6 FLOW INSTRUMENTS INSTALLATION

A. Airflow Sensors:

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1. Install sensors in straight sections of duct with manufacturer-recommended straight duct upstream and downstream of sensor.
2. Installed sensors shall be accessible for visual inspection and service. Install access door(s) in duct or equipment located upstream of sensor, to allow service personnel to hand clean sensors.

B. Liquid and Steam Sensors:

1. Install sensors in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Alert manufacturer where installation cannot accommodate recommended clearance, and solicit recommendations for field modifications to installation, such as flow straighteners, to improve condition.
3. Install pipe reducers for in-line sensors smaller than line size. Position reducers at distance from sensor to avoid interference and impact on accuracy.
4. Install in-line sensors with flanges or unions to provide drop-in and -out installation.

C. Liquid Flow Meters:

1. Install meters in straight sections of piping with manufacturer-recommended straight piping upstream and downstream of sensor.
2. Install pipe reducers for in-line meters smaller than line size. Install reducers at distance from meter to avoid interference and impact on accuracy.
3. Install in-line meters with flanges or unions to provide drop-in and -out installation.
4. Insertion Meters:

    a. Install system process connections full size of meter connection, but not less than [NPS 1 (DN 25)] [NPS 1-1/2 (DN 40)] [NPS 2 (DN 50)] <**Insert pipe size**>. Provide [**stainless-steel**]bushing if required to mate to system connection.
    b. Install meter in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
    c. In applications where top-dead-center location is not possible due to field constraints, install meter at location along top half of pipe if acceptable by manufacturer for mounting orientation.

D. Liquid Switches:

1. Install system process connection full size of switch connection, but not less than [NPS 1 ((DN 25))] [NPS 1-1/2 ((DN 40))] [NPS 2 ((DN 50))] <**Insert pipe size**>. Install [**stainless-steel**]bushing if required to mate switch to system connection.
2. Install switch in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.
3. In applications where top-dead-center location is not possible due to field constraints, install switch at location along top half of pipe if switch is acceptable by manufacturer for mounting orientation.

E. Transmitters:

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1. Install airflow transmitters serving an air system in a single location adjacent to or within system control panel.
2. Install liquid flow transmitters, not integral to sensors, in vicinity of sensor. Where multiple flow transmitters serving same system are located in same room, co-locate transmitters by system to provide service personnel a single and convenient location for inspection and service.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification[**and on face of ceiling directly below instruments concealed above ceilings**].

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.9 CHECKOUT PROCEDURES

A. Description:

1. Check out installed products before continuity tests, leak tests, and calibration.
2. Check instruments for proper location and accessibility.
3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

B. Flow Instrument Checkout:

1. Verify that sensors are installed correctly with respect to flow direction.
2. Verify that sensor attachment is properly secured and sealed.
3. Verify that processing tubing attachment is secure and isolation valves have been provided.
4. Inspect instrument tag against approved submittal.
5. Verify that recommended upstream and downstream distances have been maintained.

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3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after-calibration-indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

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3.11 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**three**] [**six**] [**nine**] [**12**] months' full maintenance by [**skilled employees of systems and equipment Installer**] [**manufacturer's authorized service representative**]. Include [**monthly**] [**quarterly**] [**semiannual**] [**annual**] preventive maintenance, repair, or replacement of worn or defective components, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.12 DEMONSTRATION

A. [**Engage a factory-authorized service representative to train**] [**Train**] Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record videos on DVD disks.

D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 230923.14

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SECTION 230923.22 - POSITION INSTRUMENTS

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 position limit switches for use in direct-digital control systems for HVAC.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section **230923.22**.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include operating characteristics, electrical characteristics, and furnished accessories indicating default control signal with loss of power and electrical power requirements.
2. Include product description with complete technical data and product specification sheets.

B. Shop Drawings:

1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.
3. Include number-coded identification system for unique identification of wiring.

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PART 2 - PRODUCTS

2.1 POSITION LIMIT SWITCHES

A. Products: Subject to compliance with requirements, provide the following:

1. Omron; Model D4A.
2. .

B. Description: Select type of actuating head (plunger, roller lever, or rod) to suit application.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Performance:

1. Life expectancy: Not less than 30 million mechanical operations and 750,000 electrical operations.
2. Operating Frequency: 300 mechanical operations per minute and 30 electrical operations per minute.
3. Voltage: 125-, 250-, 480-, and 600-V ac or 8-, 12-, 14-, 24-, 30-, 48-, 125-, and 250-V dc, as required by application.
4. Current Rating: As required by application.
5. Temperature Rise: 50 deg C.
6. Ambient Temperature: 14 to 175 deg F .
7. Ambient Relative Humidity: 35 to 95 percent.

D. Construction:

1. NEMA 250, Type 4X enclosure.
2. Switch Type: SPDT or DPDT, as required by application.
3. Status indicator integral to switch. Field switchable to light when contacts are actuated and operating, or contacts are free and not operating.
4. Electrical Connection: Screw or plug-in terminals.
5. Conduit Connection: NPS 1/2 ((DN 50)).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

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C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a 5 pound force.

C. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not to overstress threads by using excessive force or oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to:

    a. Laboratory exhaust airstreams.
    b. Process exhaust airstreams.

3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRICAL POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

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C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 POSITION INSTRUMENTS INSTALLATION

A. Mounting Location:

1. Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, and conduit to final location.
2. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated, using neoprene gaskets or grommets.

3.5 ADJUSTMENT, CALIBRATION, AND TESTING

A. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

B. Switches: Calibrate switches to make or break contact at set points indicated.

END OF SECTION 230923.22

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SECTION 230923.23 - PRESSURE INSTRUMENTS

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. Liquid-pressure transmitters.

B. Related Requirements:

   1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
   2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section **230923.23**.

1.3 DEFINITIONS

A. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bi-directional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from technician's hand-held device or laptop to a control, asset management, safety, or other system using any control platform.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

   1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
   3. Product description with complete technical data, performance curves, and product specification sheets.

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4. Installation instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to room, duct, pipe, and equipment.
2. Wall-mounted instruments located in finished space, showing relationship to light switches, fire alarm devices, and other installed devices.
3. Size and location of wall access panels for instruments installed behind walls.
4. Size and location of ceiling access panels for instruments installed in accessible ceilings.

B. Product Certificates: For each product requiring a certificate.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

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a. If instrument alone cannot comply with requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, filtered, and ventilated as required by instrument and application.

2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument-installed location shall dictate following NEMA 250 enclosure requirements:
   a. Mechanical Equipment Rooms:

      1) Chiller and Boiler Rooms: Type 12.

2.2 LIQUID-PRESSURE TRANSMITTERS

A. Liquid Gage Pressure Transmitter with Adjustable Span:

1. Products: Subject to compliance with requirements, provide the following:

   a. Rosemount Inc., Emerson Electric Co.; Model 3051CG.
   b. Dust ignition proof for Class II, Division 1, Groups E, F, and G.

2. Performance:

   a. Range: Minus 300 to 300 psig .
   b. Span: Field adjustable.
   c. Minimum Span: 3 psig .
   d. Reference Accuracy: Within 0.07 percent of span or better.
   e. Stability: Within 0.125 percent of upper range limit for 5 years.
   f. Overpressure Limits: 3626 psig .
   g. Process Temperature Limits: Minus 40 to 250 deg F .
   h. Ambient Temperature Limits: Minus 40 to 185 deg F .
   i. Temperature Effect: Within 0.025 percent of upper range limit plus 0.125 percent of span.
   j. Shock and vibration shall not harm the transmitter.

3. Analog Output Current Signal:

   a. Two-wire, 4- to 20-mA dc current source.
   b. Signal capable of operating into 1000-ohm load.
   c. Digital signal based on HART protocol carried with current signal.
   d. Dampening: Field selectable from zero to 30 seconds.

4. Operator Interface: Zero and span adjustments located behind cover.
5. Construction:

   a. Non-wetted parts of transmitter constructed of aluminum or stainless steel.
   b. Enclosure with removable cover on each side.

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c. Wetted parts of transmitter constructed of Type 316 stainless steel.
d. Threaded, NPS 1/2 process connection on bottom of instrument.
e. Drain/vent valve on process connection.
f. Two 1/2-inch trade size conduit connections on side of instrument enclosure.
g. Screw terminal block for wire connections.
h. NEMA 250, Type 4X.
i. Mounting Bracket: Appropriate for installation.

B. Liquid-Pressure Differential Transmitter with Adjustable Span:

1. Products: Subject to compliance with requirements, provide the following:

a. Rosemount Inc., Emerson Electric Co.; Model 3051CD.

2. Hazardous Classification: FM Approved for hazardous environments.

a. Intrinsically safe for Classes I, II, and III; Divisions 1 and 2; Groups A through H.
b. Explosion proof for Class I, Division 1, Groups B, C, and D.
c. Dust ignition proof for Class II, Division 1, Groups E, F, and G.

3. Performance:

a. Range: Minus 300 to 300 psig .
b. Span: Field adjustable.
c. Minimum Span: 3 psig .
d. Reference Accuracy: Within 0.07 percent of span or better.
e. Stability: Within 0.125 percent of upper range limit for 5 years.
f. Overpressure Limits: 3626 psig .
g. Process Temperature Limits: Minus 40 to 250 deg F .
h. Ambient Temperature Limits: Minus 40 to 185 deg F .
i. Temperature Effect: Within 0.025 percent of upper range limit plus 0.125 percent of span.
j. Shock and vibration shall not harm the transmitter.

4. Analog Output Current Signal:

a. Two-wire, 4- to 20-mA dc current source.
b. Signal capable of operating into 1000-ohm load.
c. Digital signal based on HART protocol carried with current signal.
d. Dampening: Field selectable from zero to 30 seconds.

5. Operator Interface: Zero and span adjustments located behind cover.
6. .
7. Construction:

a. Non-wetted parts of transmitter constructed of aluminum or stainless steel.
b. Enclosure with removable cover on each side.
c. Wetted parts of transmitter constructed of Type 316 stainless steel.

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d. Threaded, NPS 1/2 process connection on bottom of instrument.
e. Drain/vent valve on process connection.
f. Two 1/2-inch trade size conduit connections on side of instrument enclosure.
g. Screw terminal block for wire connections.
h. NEMA 250, Type 4X.
i. Mounting Bracket: Appropriate for installation.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled pressure instruments, as indicated by instrument requirements. Affix standards organization's certification and label.

B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to a 5 pound force.

C. Provide ceiling, floor, roof, wall openings, and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

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D. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not to overstress threads by using excessive force or oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

E. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRICAL POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 PRESSURE INSTRUMENT INSTALLATION

A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid pressure associated with individual air-handling units and associated connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.

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3. Install liquid and steam pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air-pressure switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments (except pressure gages) in steam, liquid, and liquid-sealed piped services below their process connection point. Slope tubing down to instrument with a slope of [**2**] [**3**] <**Insert number**> percent.
7. Install instruments in dry gas and noncondensable vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of [**2**] [**3**] <**Insert number**> percent.

B. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

C. Duct Pressure Sensors:

1. Install sensors using manufacturer's recommended upstream and downstream distances.
2. Unless indicated on Drawings, locate sensors approximately 75 percent of distance of longest hydraulic run. Location of sensors shall be submitted and approved before installation.
3. Install mounting hardware and gaskets to make sensor installation airtight.
4. Route tubing from the sensor to transmitter.
5. Use compression fittings at terminations.
6. Install sensor in accordance with manufacturer's instructions.
7. Support sensor to withstand maximum air velocity, turbulence, and vibration encountered to prevent instrument failure.

D. Liquid-Pressure Differential Switches:

1. Where process connections are located in mechanical equipment room, install switch in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate switch near system control panel.
3. Where multiple switches serving same system are installed in same room, install switches by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than NPS 1/2 . Install stainless-steel bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to switch.

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6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each switch connection.
8. Do not mount switches on rotating equipment.
9. Install switches in a location free from vibration, heat, moisture, or adverse effects, which could damage the switch and hinder accurate operation.
10. Install switches in an easily accessible location serviceable from floor.

E. Liquid-Pressure Transmitters:

1. Where process connections are installed in mechanical equipment room, install transmitter in convenient and accessible location near system control panel.
2. Where process connections are installed outside mechanical rooms, route processing tubing to mechanical room housing system control panel and locate transmitter near system control panel.
3. Where multiple transmitters serving same system are installed in same room, install transmitters by system to provide service personnel a single and convenient location for inspection and service.
4. System process tubing connection shall be full size of switch connection, but not less than NPS 1/2 . Install stainless-steel bushing if required to mate switch to system connection.
5. Connect process tubing from point of system connection and extend to transmitter.
6. Install isolation valves in process tubing as close to system connection as practical.
7. Install dirt leg and drain valve at each transmitter connection.
8. Do not mount transmitters on equipment.
9. Install in a location free from vibration, heat, moisture, or adverse effects, which could damage and hinder accurate operation.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification.

3.6 CHECKOUT PROCEDURES

A. Check out installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that impact performance.

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3.7 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration shall comply with instrument manufacturer's recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of project design values.

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3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate pressure instrument demonstration video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record videos on DVD disks.

D. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 230923.23

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SECTION 230923.27 - TEMPERATURE INSTRUMENTS

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. Air temperature sensors.
2. Combination air temperature sensors and switches.
3. Air temperature switches.
4. Air temperature RTD transmitters.
5. Liquid and steam temperature sensors.
6. High-end, commercial-grade, liquid, and steam temperature sensors.
7. Industrial-grade liquid and steam temperature sensors.
8. Liquid temperature switches.
9. High-end, commercial-grade, liquid, and steam temperature transmitters.
10. Industrial-grade liquid and steam temperature transmitters.

B. Related Requirements:

1. Section 230923 "Direct-Digital Control System for HVAC" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.
2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to Section **230923.27**.

1.3 DEFINITIONS

A. HART (Highway Addressable Remote Transducer) Protocol: The global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bidirectional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

B. RTD: Resistance temperature detector.

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1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation operation and maintenance instructions, including factors affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

C. Samples: For each exposed product installed in finished space.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Product installation location shown in relationship to room, duct, pipe, and equipment.
2. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices, and other installed devices.
3. Sizes and locations of wall access panels for instruments installed behind walls.
4. Sizes and locations of ceiling access panels for instruments installed in inaccessible ceilings.

B. Product Certificates: For each product requiring a certificate.

C. Field quality-control reports.

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1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

    a. If instrument alone cannot meet requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, filtered, and ventilated as required by instrument and application.

2. Instruments and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Instrument's installed location shall dictate following NEMA 250 enclosure requirements:
    a. Mechanical Equipment Rooms:

        1) Chiller and Boiler Rooms: Type 12.

3. Products: Subject to compliance with requirements, provide the following:

    a. Rosemount Inc., Emerson Electric Co.; Series 78S.

4. Resistance temperature sensors shall comply with IEC 60751, Class A requirements.
5. Platinum with a value of 100 ohms at zero deg C and a temperature coefficient of 0.00385 ohm/ohm/deg C.
6. Encase RTD in a Type 316 stainless-steel sheath with a 0.25-inch OD.
7. Provide two-wire, PTFE-insulated, nickel-coated, 22-gage, stranded copper leads.
8. Provide spring-loaded RTDs for thermowell installations.
9. Performance Characteristics:

    a. Range: Minus 328 to 932 deg F .
    b. Interchangeable Accuracy: Within 0.27 deg F at 32 deg F .
    c. Stability: Within 0.05 percent maximum ice-point resistance shift after 1000 hours at 752 deg F .
    d. Hysteresis: Within 0.04 percent of range.

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e. Response Time: 62.8 percent of change in 4 seconds with water flowing across sensor at 3 fps .
f. Self-Heating: 18-mW minimum power dissipation required to cause a 1.8 deg F (1 deg C) temperature measurement error in water flowing at 3 fps .

B. Thermowells:

1. Products: Subject to compliance with requirements, provide the following:

a. Rosemount Inc., Emerson Electric Co.; Series 91.
b. .

2. Stem: Straight or stepped or tapered shank formed from solid bar stock.
3. Material: Type 304 or Type 316 stainless steel.
4. Process Connection: Threaded, NPS 3/4 , or flange-face, NPS 1 (DN 25), Class 150 ASME B16.5.
5. Sensor Connection: Threaded, NPS 1/2 .
6. Bore: Sized to accommodate sensor with tight tolerance between sensor and well.
7. Furnish thermowells installed in insulated pipes and equipment with an extended neck that extends beyond the face of the insulation covering.
8. Length: As required by application and pipe size.
9. Thermowells furnished with heat-transfer compound to eliminate air gap between wall of sensor and thermowell and to reduce time constant.

C. Connection Heads:

1. Products: Subject to compliance with requirements, provide the following:

a. Rosemount Inc., Emerson Electric Co.; Connection Head.

2. Housing: Low-copper cast-aluminum alloy, complying with NEMA 250, Type 4.
3. Terminals: Six or eight as required by sensor, nickel-plated brass.
4. Conduit Connection: 1/2-inch trade size.
5. Sensor Connection: Threaded, NPS 1/2 .

D. Assembly: Sensor manufacturer shall furnish sensor, thermowell, and sensor connection head to provide a matched assembly.
1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

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C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a 5 pound force.

C. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 ELECTRIC POWER

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

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C. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

D. Furnish and install raceways. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems."

3.4 TEMPERATURE INSTRUMENT INSTALLATIONS

A. Mounting Location:

1. Roughing In:

   a. Outline instrument mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
   b. Provide independent inspection to confirm that proposed mounting locations comply with requirements indicated and approved submittals.

      1) Indicate dimensioned locations with mounting height for all surface-mounted products on Shop Drawings.
      2) Do not begin installation without submittal approval of mounting location.

   c. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

2. Install switches and transmitters for air and liquid temperature associated with individual air-handling units and associated connected ductwork and piping near air-handling units co-located in air-handling unit system control panel to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install air temperature switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer's mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.

B. Special Mounting Requirements:

1. Protect products installed outdoors from solar radiation, building and wind effect with stand-offs and shields constructed of Type 316 stainless.
2. Temperature instruments having performance impacted by temperature of mounting substrate shall be isolated with an insulating barrier located between instrument and substrate to eliminate effect. Where instruments requiring insulation are located in finished space, conceal insulating barrier in a cover

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matching the instrument cover.

C. Mounting Height:

1. Mount temperature instruments in user-occupied space to match mounting height of light switches unless otherwise indicated on Drawings. Mounting height shall comply with codes and accessibility requirements.
2. Mount switches and transmitters located in mechanical equipment rooms and other similar space not subject to code or state and Federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.

    a. Make every effort to mount at 60 inches .

D. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

E. Space Temperature Sensor Installation:

1. Conceal assembly in an electrical box of sufficient size to house sensor and transmitter, if provided.
2. Install electrical box with a faceplate to match sensor cover if sensor cover does not completely cover electrical box.
3. In finished areas, recess electrical box within wall.
4. In unfinished areas, electrical box may be surface mounted if electrical light switches are surface mounted. Use a cast-aluminum electric box for surface-mounted installations.
5. Align electrical box with other electrical devices such as visual alarms and light switches located in the vicinity to provide a neat and well-thought-out arrangement. Where possible, align in both horizontal and vertical axis.

F. Outdoor Air Temperature Sensor Installation:

1. Mount sensor in a discrete location facing north.
2. Protect installed sensor from solar radiation and other influences that could impact performance.
3. If required to have a transmitter, mount transmitter remote from sensor in an accessible and serviceable location indoors.

G. Single-Point Duct Temperature Sensor Installation:

1. Install single-point-type, duct-mounted, supply- and return-air temperature sensors. Install sensors in ducts with sensitive portion of the element installed in center of duct cross section and located to sense near average temperature. Do not exceed 24 inches (610 mm) in sensor length.
2. Install return-air sensor in location that senses return-air temperature without influence from outdoor or mixed air.
3. Rigidly support sensor to duct and seal penetration airtight.
4. If required to have transmitter, mount transmitter remote from sensor at

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accessible and serviceable location.

H. Averaging Duct Temperature Sensor Installation:

1. Install averaging-type air temperature sensor for temperature sensors located within air-handling units, similar equipment, and large ducts with air tunnel cross-sectional area of 20 sq. ft. (1.86 sq. m) and larger.
2. Install sensor length to maintain coverage over entire cross-sectional area. Install multiple sensors where required to maintain the minimum coverage.
3. Fasten and support sensor with manufacturer-furnished clips to keep sensor taut throughout entire length.
4. If required to have transmitter, mount transmitter in an accessible and serviceable location.

I. Low-Limit Air Temperature Switch Installation:

1. Install multiple low-limit switches to maintain coverage over entire cross-sectional area of air tunnel.
2. Fasten and support sensing element with manufacturer-furnished clips to keep element taut throughout entire length.
3. Mount switches outside of airstream at a location and mounting height to provide easy access for switch set-point adjustment and manual reset.
4. Install on entering side of cooling coil unless otherwise indicated on Drawings.

J. Liquid Temperature Sensor Installation:

1. Assembly shall include sensor, thermowell and connection head.
2. For pipe NPS 4 (DN 100) and larger, install sensor and thermowell length to extend into pipe between 50 to 75 percent of pipe cross section.
3. For pipe smaller than NPS 4 (DN 100):

    a. Install reducers to increase pipe size to NPS 4 ((DN 100))at point of thermowell installation.
    b. For pipe sizes NPS 2-1/2 and NPS 3 (DN 65 and DN 80), thermowell and sensor may be installed at pipe elbow or tee to achieve manufacturer-recommended immersion depth in lieu of increasing pipe size.
    c. Minimum insertion depth shall be 2-1/2 inches (65 mm).

4. Install matching thermowell.
5. Fill thermowell with heat-transfer fluid before inserting sensor.
6. Tip of spring-loaded sensors shall contact inside of thermowell.
7. For insulated piping, install thermowells with extension neck to extend beyond face of insulation.
8. Install thermowell in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement. If top dead center location is not possible due to field constraints, install thermowell at location along top half of pipe.

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3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing shall have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification.

3.6 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

B. Wash and shine glazing.

C. Polish glossy surfaces to a clean shine.

3.7 CHECK-OUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check temperature instruments for proper location and accessibility.

C. Verify sensing element type and proper material.

D. Verify location and length.

E. Verify that wiring is correct and secure.

3.8 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration shall meet instrument manufacturer's written instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.

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7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistance source.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

E. Switches: Calibrate switches to make or break contact at set points indicated.

F. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistance source.

3.9 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 installations, including connections.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

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3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain temperature instruments.

B. Provide a complete set of instructional videos covering each product specified and installed and showing the following:

1. Software programming.
2. Calibration and test procedures.
3. Operation and maintenance requirements and procedures.
4. Troubleshooting procedures.

C. Coordinate video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

D. Record videos on DVD disks.

E. Owner shall have right to make additional copies of video for internal use without paying royalties.

END OF SECTION 230923.27

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SECTION 230993.11 - SEQUENCE OF OPERATIONS FOR HVAC DDC

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 control sequences for DDC for HVAC systems, subsystems, and equipment.

B. Related Requirements:

1. Section 230923 "DDC Systems for HVAC" for control equipment.

1.3 DEFINITIONS

A. Analog Output: Proportional output signal (zero- to 10-V dc, 4 to 20 mA).

B. Binary Output: On/off output signal or contact closure.

C. DDC: Direct digital control.

D. Digital Output: Data output that must be interpreted digitally.

1.4 ACTION SUBMITTALS

A. Product Data:

1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.

B. Shop Drawings:

1. Riser diagrams showing control network layout, communication protocol, and wire types.

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2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.5 PCA PLANT CONTROL SEQUENCES

A. Refer to drawings for sequences of operation.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230993.11

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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.
2. Chilled-water piping.
3. Dual-temperature heating and cooling water piping.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 ACTION SUBMITTALS

A. Product Data: Include 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. Plastic pipe and fittings with solvent cement.
2. RTRP and RTRF with adhesive.
3. Pressure-seal fittings.
4. Chemical treatment.
5. 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

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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.

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, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

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

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file formats will not be accepted.

1.6 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.

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.

1.7 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.

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1.8 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

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. Hot-Water Heating Piping: 250 psig at 200 deg F .
2. Chilled-Water Piping: 250 psig at 200 deg F .
3. Dual-Temperature Heating and Cooling Water Piping: 250 psig at 200 deg F .

2.2 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.

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2.3 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 (3.2-mm) 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. 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.

2.4 BYPASS CHEMICAL FEEDER

A. Description: Welded steel construction; 125-psig (860-kPa) working pressure; 5-gal. (19-L) capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

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.

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D. Provide pipe hangers and supports in accordance with ASTM B31.9 unless indicated otherwise.

E. Use butterfly valves for shut off and to isolate equipment, part of systems, or vertical risers.

F. Use 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, chilled and condenser water systems .Use only butterfly valves in chilled and condenser water systems for throttling and isolation service.

I. Butterfly valves shall be lug type.

J. 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.

3.3 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be the following:

B. Hot-water heating piping installed belowground and within slabs shall be the following:

C. Steel Pipe: ASTM A 53, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black with ASME C105 polyethylene jacket, or double layer, half-lapped 10 mil polyethylene tape.

D. Fittings: ASTM A 234 forged steel welding type. With double layer, half-lapped 10 mil polyethylene tape.

E. Joints: AWS D1.1, welded.

F. Casing: Closed glass cell insulation.

G. Chilled-water piping, aboveground, NPS 2-1/2 (DN 65) 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.

H. Chilled-water piping installed belowground and within slabs shall be the following:

1. Steel Pipe: ASTM A 53, Schedule 40, 0.375 inch wall for sizes 12 inch and over, black with AWWA C105 polyethylene jacket, or double layer, half-lapped 10 mil polyethylene tape.

a. Fittings: ASTM A 234, forged steel welding type.

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b. Joints: AWS D1.1, welded.
c. Casing: Closed glass cell insulation..

I. Dual-temperature heating and cooling water piping, aboveground, NPS 2-1/2 (DN 65) 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.

J. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type L or M, annealed-temper copper tubing with soldered or flared joints.
3.

3. Expansion/contraction compensation will be accomplished utilizing factory prefabricated and preinsulated expansion elbows, Z-bends, expansion loops and anchors specifically designed for the intended application. External expansion compensation utilizing flexible expansion pads (minimum one inch thickness), extending on either side, both inside and outside the radius of the fittings shall be used with all fittings having expansion in excess of 1/2".

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.

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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 (DN 20) ball valve, and short NPS 3/4 (DN 20) 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 valves according to Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

Q. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

R. Install shutoff valve immediately upstream of each dielectric fitting.

S. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

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3.5 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. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) 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.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 (DN 20): Maximum span, 7 feet (2.1 m).
2. NPS 1 (DN 25): Maximum span, 7 feet (2.1 m).
3. NPS 1-1/2 (DN 40): Maximum span, 9 feet (2.7 m).
4. NPS 2 (DN 50): Maximum span, 10 feet (3 m).
5. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m).
6. NPS 3 (DN 80) and Larger: Maximum span, 12 feet (3.7 m).

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4 (DN 20): Maximum span, 5 feet (1.5 m); minimum rod size, 1/4 inch (6.4 mm).
2. NPS 1 (DN 25): Maximum span, 6 feet (1.8 m); minimum rod size, 1/4 inch (6.4 mm).
3. NPS 1-1/4 ((DN 32):)Maximum span, 7 feet (2.1 m); minimum rod size, 3/8 inch (10 mm).
4. NPS 1-1/2 (DN 40): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
5. NPS 2 (DN 50): Maximum span, 8 feet (2.4 m); minimum rod size, 3/8 inch (10 mm).
6. NPS 2-1/2 (DN 65): Maximum span, 9 feet (2.7 m); minimum rod size, 3/8 inch (10 mm).
7. NPS 3 (DN 80) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (10 mm).

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F. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

3.6 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.

3.7 FLANGES, UNIONS, COUPLINGS, AND MECHANICAL JOINT RESTRAINTS

1. Ferrous Piping: 150 psig forged steel, slip on.
2. Gaskets: 1/16 inch thick non-asbestos preformed gaskets, aramid fibers with nitrile (NBR) binder; Durlon "8500 Green", Garlock "IFG 5500", or approved equal.

3.8 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.

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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. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.9 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.

3.10 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

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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.
        .

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

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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.

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PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 232113

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SECTION 232116 - HYDRONIC PIPING SPECIALTIES

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 special-duty valves and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Dual-temperature heating and cooling water piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Hydronic specialties.
4. Provide product data for manufactured products and assemblies required for this project. Include component rough in requirements, service sizes, and finishes. Include product description, model, dimensions, and weight.
5. Include data substantiating that materials comply with requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1. Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

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 expansion tanks and air separators.

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1.5 MAINTENANCE SERVICE FOR GLYCOL-PROTECTED SYSTEMS

A. Perform project visit, 30 days after system startup, to make glycol fluid concentration analysis on site with refractive index measurement instrument. Provide written report of findings to maintenance personnel, covering corrective actions needed including analysis and amounts of glycol or water added as part of Contract work. Include pH analysis of system contents and perform work required to adjust pH to a level of 8.0 or higher, and add inhibitors needed to maintain pH.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Division 1.

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.

1.8 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

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. Hot-Water Heating Piping: 250 psig at 250 deg F (121 deg C).

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2. Chilled-Water Piping: 250 psig at 200 deg F (93 deg C).
3. Dual-Temperature Heating and Cooling Water Piping: 250 psig at 200 deg F (93 deg C).

2.2 VALVES

A. Butterfly Valves: Comply with requirements specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230923.11 "Control Valves."

2.3 PUMP SUCTION FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide one of the following:

1. Bell & Gossett ITT.
2. Patterson
3. or approved equal.

B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning. Pressure drop at maximum pump flow shall not exceed 2 psig.

C. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

2.4 PRESSURE AND TEMPERATURE PLUGS

A. Manufacturers: Subject to compliance with requirements, provide one of the following:

1. Duro Instrument Co.
2. Trerice Co.
3. Universal.
4. Weksler.
5. or approved equal.

B. Stainless steel combination pressure-temperature test plugs with neoprene valve core where shown on the drawings. Provide 2" bi-metal pocket test thermometers with 0 to 220 degrees F scale and plug adapter to the DEN Project Manager. Provide two 0-100 psi, 4-1/2" dial NPT conn. pressure gauges with pressure gauge adaptors to DEN Project Manager.

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2.5 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett Domestic Pump.
    d. Nexus Valve, Inc.
    e. Taco, Inc.
    f. or approved equal.

3. Body: Bronze.
4. Internal Parts: Nonferrous.
5. Operator: Screwdriver or thumbscrew.
6. Inlet Connection: NPS 1/2 (DN 15).
7. Discharge Connection: NPS 1/8 (DN 6).
8. CWP Rating: 150 psig (1035 kPa).
9. Maximum Operating Temperature: 225 deg F (107 deg C).

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett Domestic Pump.
    d. Nexus Valve, Inc.
    e. Taco, Inc.
    f. or approved equal.

2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2 (DN 15).
6. Discharge Connection: NPS 1/4 (DN 8).
7. CWP Rating: 150 psig (1035 kPa).
8. Maximum Operating Temperature: 240 deg F (116 deg C).
9. Float Type: Brass body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve. Minimum ratings not less than 250 degrees F and 150 psi working pressure.
10. Washer Type: Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

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C. Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Taco, Inc.
   e. Wheatley.
   f. or approved equal.

2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. (379-L) unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig (860-kPa) working pressure and 250 deg F (121 deg C) maximum operating temperature.
4. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
5. Gage Glass: Full height with dual manual shutoff valves, [**3/4-inch- (20-mm-)**] <**Insert dimension**> diameter gage glass, and slotted-metal glass guard.

D. Diaphragm-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. AMTROL, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump.
   d. Taco, Inc.
   e. Wheatley.
   f. or approved equal.

2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
5. Accessories: Pressure gage and air-charging fitting, tank drain; precharge to 12 psig. Adjust as needed for proper system functionality.

E. Tangential-Type Air Separators:

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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett Domestic Pump.
    d. Taco, Inc.
    e. Wheatley.
    f. or approved equal.

2. Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.
3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
4. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
5. Blowdown Connection: Threaded.
6. Size: Match system flow capacity.

F. In-Line Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Armstrong Products, Inc.
    c. Bell & Gossett Domestic Pump.
    d. Taco, Inc.
    e. Wheatley.
    f. or approved equal.

2. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
3. Maximum Working Pressure: Up to 175 psig (1207 kPa).
4. Maximum Operating Temperature: Up to 300 deg F (149 deg C).

G. Air Purgers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. AMTROL, Inc.
    b. Armstrong Pumps, Inc.
    c. Bell & Gossett Domestic Pump.
    d. Taco, Inc.
    e. or approved equal.

2. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.

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3. Maximum Working Pressure: 150 psig (1035 kPa).
4. Maximum Operating Temperature: 250 deg F (121 deg C).

2.6 HYDRONIC PIPING SPECIALTIES

A. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Flanged ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig (5170 kPa).

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

C. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping."Section 15124 "Expansion Fittings and Loops for HVAC Piping."

2.7 GLYCOL SYSTEM

A. Mixing Tank: 45 gallon steel drum with fittings suitable for filling and hand pump for charging, rubber hose for connection of hand pump to system.

B. Storage Tank: Closed type, welded steel constructed, tested and stamped in accordance with Section 8D of ASME Code; 125 psi rating; cleaned, prime coated, and supplied with steel support saddles. Construct with tappings for installation of accessories.

C. Expansion Tank: Diaphragm expansion tank and vent fitting with air separator, and automatic air vent.

D. Air Pressure Reducing Station: Pressure reducing valve with shut-off valves, strainer, check valve, and needle valve bypass.

E. Glycol Solution: Inhibited propylene glycol and water solution mixed 50-50.

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PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install throttling-duty valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install specialties in accordance with manufacturer's instructions to provide intended performance.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

E. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

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G. Where large air quantities can accumulate, provide enlarged air collection standpipes.

H. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

I. Provide air separator on suction side of system circulation pump and connect to expansion tank.

J. Provide valved drain and hose connection on strainer blow down connection.

K. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.

L. Provide individual pump discharge isolation, balancing and check valves on discharge side of base mounted centrifugal pumps.

M. Provide isolation valves on water inlet to terminal heating units such as radiation, unit heaters, and fan coil unit.

N. Provide flow-setting balancing valves on water outlet from terminal heating units.

O. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

P. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

Q. Pipe relief valve outlet to nearest floor drain.

R. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

S. Clean and flush glycol system before adding glycol solution.

T. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 12 psig.

U. Perform tests determining strength of ethylene glycol and water solution and submit written test results.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

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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 232116

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SECTION 232123 - HYDRONIC PUMPS

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. Separately coupled, base-mounted, end-suction centrifugal pumps.
   2. Vertical Inline Multi-stage Centrifugal Pumps

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

   1. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For each pump.

   1. Show pump layout and connections.
   2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   3. Include diagrams for power, signal, and control wiring.

C. Millwright's Certificate: Certify that base mounted pumps have been aligned.

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1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1. Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 1.

C. Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum of five (5) years experience.

D. Alignment: Base mounted pumps shall be aligned by qualified millwright.

E. 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.

F. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products under provisions of Division 1.

B. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

C. Store pumps in clean, dry location.

D. Retain protective covers for flanges and protective coatings during storage. Maintain in

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place until installation.

E. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

F. Comply with pump manufacturer's written rigging instructions.

1.9 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American-Marsh Pumps.
2. Armstrong Pumps Inc.
3. Aurora Pump; Division of Pentair Pump Group.
4. Buffalo Pumps, Inc.
5. Crane Pumps & Systems.
6. Flowserve Corporation.
7. Goulds
8. ITT Corporation; Bell & Gossett.
9. Mepco, LLC.
10. PACO Pumps.
11. Patterson
12. Peerless Pump Company.
13. Scot Pump; Div. of Ardox Corp.
14. TACO Incorporated.
15. Thrush Company Inc.
16. or approved equal.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller

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without disconnecting piping or requiring the realignment of pump and motor shaft.

2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, secured to mounting frame, with adjustable alignment.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

    a. Enclosure: Open, dripproof.
    b. Motor Bearings: Grease-lubricated ball bearings.
    c. Unusual Service Conditions:

        1) Ambient Temperature: 90 deg, F.
        2) Altitude: 5400 above sea level.

    d. Efficiency: Premium efficient.

2.2 VERTICAL INLINE MULTI-STAGE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grundfos

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2. or approved equal.

B. Pump Construction:

1.	Suction/discharge base, pump head	Ductile Iron (ASTM 65-45-12)
2.	Shaft couplings, flange rings:	Ductile Iron (ASTM 65-45-12)
3.	Shaft	431 Stainless Steel
4.	Motor Stool	Cast Iron (ASTM Class 30)
5.	Impellers, diffuser chambers, outer sleeve:	304 Stainless Steel
6.	Impeller wear rings:	304 Stainless Steel
7.	Intermediate Bearing Journals:	Tungsten Carbide
8.	Intermediate Chamber Bearings:	Leadless Tin Bronze
9.	Chamber Bushings:	Graphite Filled PTFE
10.	O-rings:	EPDM

11. The shaft seal shall be a single balanced metal bellows cartridge with the following construction:

a.	Bellows:	904L Stainless Steel
b.	Shaft Sleeve, Gland Plate, Drive Collar:	316 Stainless Steel
c.	Stationary Ring:	Carbon
d.	Rotating Ring:	Tungsten Carbide

C. e. O-rings: EPDMShaft seal replacement shall be possible without removal of any pump components other than the coupling guard, motor couplings, motor and seal cover. Pumps with motors equal to or larger than 15 hp (fifteen horsepower) shall have adequate space within the motor stool so that shaft seal replacement is possible without motor removal.

D. The maximum working temperature shall be 250 degrees F. The maximum working pressure shall be 232 psig or 362 psig as determined by the installation requirements.

2.3 Motors

1. Motors are to be provided with the following basic features:

   Motors shall be designed for continuous duty operation, NEMA design B with a 1.15 S.F.

   Totally Enclosed Fan Cooled Motors are to be furnished with class “F” insulation. Open Drip Proof Motors are to be furnished with class “B” insulation.

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Motor nameplate shall be mounted on enclosure with stainless steel fastening pins. Nameplate shall have, as a minimum, all information as described in NEMA Standard MG 1-20.40.1.

Open Drip Proof (ODP) motors shall have drip covers.

Motors over 50 lbs shall having lifting provisions.

Motors shall have a NEMA C-Flange for vertical mounting.

2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. WARRANTY

The warranty period shall be a non-prorated period of 24 months from date of installation, not to exceed 30 months from date of manufacture.

2.4 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig (1204-kPa) pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

PART 3 - EXECUTION

3.1 PERFORMANCE REQUIREMENTS

A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

3.2 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

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C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 CONCRETE BASES

A. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

B. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

C. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

D. Install anchor bolts to elevations required for proper attachment to supported equipment.

E. Cast-in-place concrete materials and placement requirements are specified in Division 3. Comply with requirements of Division 3.

3.4 PUMP INSTALLATION

A. Comply with HI 1.4 and HI 2.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

    a. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
    b. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.

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3.5 ALIGNMENT

A. Engage a factory-authorized service representative to assist Contractor and perform alignment service.

B. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.

1. Adjust pump and motor shafts for angular and offset alignment by methods specified in HI 1.1-1.5 and HI 2.1-2.5.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.6 CONNECTIONS

A. Where installing piping adjacent to pump, allow space for service and maintenance.

B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

C. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

D. Install check, shutoff, and throttling valves on discharge side of pumps.

E. Install [**suction diffuser**] and shutoff valve on suction side of pumps.

F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

H. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to assist Contractor and perform startup service.

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1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to assist Contractor and train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

1. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

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 232123

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SECTION 233113 - METAL DUCTS

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. Single-wall rectangular ducts and fittings.
2. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain clear sizes inside lining.

B. Low Pressure: 2 inch WG positive or negative static pressure and velocities less than 2,500 fpm.

C. Medium Pressure: Three pressure classifications, as follows:

1. 3 inch WG positive or negative static pressure and velocities less than 4,000 fpm.
2. 4 inch WG positive static pressure and velocities greater than 2,000 fpm. 6 inch WG positive static pressure and velocities greater than 2,000 fpm.

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D. High Pressure: 10 inch WG positive static pressure and velocities greater than 2,000 fpm.

1.4 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes permitted except by written permission of the DEN Mechanical Engineer. Size round ducts installed in place of rectangular ducts in accordance with SMACNA [**and**] [**or**] ASHRAE table of equivalent rectangular and round ducts.

B. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

C. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

1.5 ACTION SUBMITTALS

A. Product Data: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration for duct materials duct connectors. For each type of the following products:
1. Sealants and gaskets.
2. Seismic-restraint devices.
3. Include data substantiating that materials comply with requirements.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.

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11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Other systems installed in same space as ducts.
6. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Welding certificates.

C. Field quality-control reports. Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.7 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

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1.8 QUALITY ASSURANCE

A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

B. Maintain one copy of document on site for reference by Contractor's personnel.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

E. Construct ductwork to NFPA 90A and NFPA 90B and NFPA 96 standards.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and protect products under provisions of Section 230400 "Basic HVAC Requirements" and Division 1 requirements.

B. Store all materials in location protected from water, wind, construction activities, and any other potential damage hazard.

C. Protect <**Insert item**> from <**Insert item**> by <**Insert requirement**>.

1.10 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 DUCTWORK FABRICATION

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated, but not less than 1" WG

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positive and negative pressures.

B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide [**air foil**] turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

D. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Duct Construction Standards. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.

E. Provide standard 45 degree lateral wye takeoffs.

F. 90 degree conical tee connections (spin-in fittings) may only be used downstream of a VAV terminal.

2.3 MANUFACTURED DUCTWORK AND FITTINGS

A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards -Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

B. SMANCA Type 1 offset transitions shall not be allowed without written approval from DEN Project Manager or DEN Mechanical Inspector.

C. Transverse Duct Connection System: SMACNA "E" rated SMACNA "F" rated or SMACNA "J" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.4 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements,

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materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.5 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 3 inches (76 mm).
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

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1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

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2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.8 SEISMIC-RESTRAINT DEVICES

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. Ductmate Industries, Inc.
3. Hilti Inc.
4. Kinetics Noise Control, Inc.
5. Loos & Co., Inc.
6. Mason Industries, Inc.
7. TOLCO.
8. Unistrut; an Atkore International company.
9. or approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

D. Restraint Cables: ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

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PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

D. Install in accordance with manufacturer's instructions.

E. Install round ducts in lengths not less than 12 feet unless interrupted by fittings, and in maximum practical lengths.

F. Install ducts with fewest possible joints.

G. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

H. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

I. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines. Avoid diagonal runs.

J. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

K. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

L. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

M. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

N. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of airflow.

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O. Use double nuts and lock washers on threaded rod supports.

P. Cloth backed duct tape shall not be used.

Q. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system at the end of each work shift. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

R. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

S. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

T. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

U. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

V. Painting Interiors of Metal Ducts:

1. Paint interiors of metal ducts that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 9.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

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3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For pressure classes lower than 2-inch wg, seal transverse joints.

B. Seal ducts before external insulation is applied.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
3. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

G. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

H. Provide a support with 12 inches of the end of a duct run, not including flexible duct.

I. Support vertical ducts at maximum intervals of 16 feet and at each floor.

J. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

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K. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
2. Brace a change of direction longer than 12 feet (3.7 m).

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

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B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
2. Test for leaks before applying external insulation.
3. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
4. Give seven days' advance notice for testing.

B. Duct system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Clean ductwork internally, unit-by-unit as it is installed, of dust and debris. Clean external surfaces of foreign substances, which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

C. Strip protective paper from stainless ductwork surfaces, and repair finish wherever it has been damaged.

D. Temporary Closure: At ends of ducts, which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering, which will prevent entrance of dust and debris until time connections are to be completed.

E. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

F. Use service openings for entry and inspection.

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1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

G. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

H. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

I. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.

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7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.
8. Cleanliness Verification:

    a. Visually inspect metal ducts for contaminants.
    b. Where contaminants are discovered, re-clean, and reinspect ducts.

3.10 CLEANING EXISTING SYSTEMS

A. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Use existing service openings where possible.
2. Create other openings to comply with duct standards.
3. Disconnect flexible ducts as needed for cleaning and inspection.
4. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
5. Remove and reinstall ceiling sections to gain access during the cleaning process.

B. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97% collection efficiency for 0.3-micron size (or larger) particles.
2. When venting vacuuming system to the outside, use filtration to contain debris removed from HVAC system, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

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1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide operative drainage system for washdown procedures.
7. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

F. Cleanliness Verification:
1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal ducts for contaminants.
3. Where contaminants are discovered, re-clean and reinspect ducts.

G. Verification of Coil Cleaning: Cleaning must restore coil pressure drop to within 10% of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

3.11 FINAL CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment, which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

B. Clean duct systems with high power vacuum machines. Protect equipment, which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

3.12 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

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3.13 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units <**Insert equipment**>:

a. Pressure Class: Positive 2-inch wg (500 Pa).
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.

B. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
1) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

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 233113

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SECTION 233300 - AIR DUCT ACCESSORIES

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. Manual volume dampers.
2. Flange connectors.
3. Turning vanes.
4. Duct accessory hardware.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include dimension data, materials, pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

a. Design Data: Provide engineering calculations, referenced to specifications and AMCA 301 standards indicating that maximum room sound levels are not exceeded.

2. Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
3. Fire, Smoke, and Combination Fire Smoke Dampers: Submit manufacturer’s product data.

a. Include UL ratings for leakage class (I, II, or III), velocity (2000, 3000, or 4000 fpm), differential pressure (4, 6, or 8 inches WG) and elevated temperature (250 or 350 degrees F).
b. Indicate materials, construction, and dimensions.
c. Verify conformance to NFPA, UL, and applicable building code.
d. Include pressure drop data for air flow in either direction for all damper sizes in accordance with AMCA 500-D test figures 5.2 (Ducted Inlet, Free Outlet), 5.3 (Ducted Inlet, Ducted Outlet) and 5.5 (Free Inlet, Free Outlet).

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e. Include a copy of UL Installation Instructions.
f. Damper access and identification label product data a sample.

4. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Test Reports: Indicate acoustic housings meet or exceed specified sound transmission loss values.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories 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".

1.6 QUALITY ASSURANCE

A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. (or other testing agency acceptable to the authority having jurisdiction) as suitable for the purpose specified and indicated.

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1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products under provisions of Section 230400 "Basic HVAC Requirements" and Division 1.

B. Store all materials in location protected from water, construction activities, and any other potential damage hazard.

C. Protect dampers from damage to operating linkages and blades.

1.8 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90 (Z275).
2. Exposed-Surface Finish: Mill phosphatized.

B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

C. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Air Balance Inc.; a division of Mestek, Inc.
    b. American Warming and Ventilating; a division of Mestek, Inc.
    c. Flexmaster U.S.A., Inc.
    d. McGill AirFlow LLC.
    e. Nailor Industries Inc.
    f. Pottorff.
    g. Ruskin Company.
    h. Trox USA Inc.
    i. Vent Products Company, Inc.
    j. or approved equal.

2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:

    a. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel.
    b. Mitered and welded corners.
    c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

    a. Multiple or single blade.
    b. Opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized-steel, 0.064 inch (1.62 mm) thick.

6. Blade Axles: Galvanized steel.
7. Bearings:

    a. Oil-impregnated bronze.
    b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

2.4 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
4.
5. or approved equal.

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B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.5 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO Incorporated.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
7. or approved equal.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Single wall.

E. Vane Construction: Single wall for ducts up to [48 inches (1200 mm)] wide and double wall for larger dimensions.

2.6 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. Elgen Manufacturing.
4. Ventfabrics, Inc.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
6. or approved equal.

B. Materials: Flame-retardant or noncombustible fabrics.

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C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

2.7 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

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E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

G. Provide balancing dampers on high velocity systems where indicated. Refer to Section 233600 "Air Terminal Units".

3.3 LABELING

A. Provide identification and access labels for all fire dampers, smoke dampers and combination fire smoke dampers.

B. Labels shall be plastic with pressure-sensitive, permanent-type, self-adhesive back. Font shall be Arial, with a minimum text height of half an inch. Font color shall be red and background color shall be white.

C. Identification labels shall be located on the damper sleeve or frame on both side of the damper. The label shall indicate “FIRE DAMPER”, “SMOKE DAMPER” and/or “COMBINATION FIRE/SMOKE DAMPER”.

D. Access labels shall be provided to indicate locations for access to reset and maintain the damper. The label shall indicate “FIRE DAMPER ACCESS”, “SMOKE DAMPER ACCESS” and/or “COMBINATION FIRE/SMOKE DAMPER ACCESS”.

1. Access label location shall be as follows:

a. Damper in continuous duct with duct access with 12 inches of the damper:
1) .

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

B. MANUFACTURER'S FIELD SERVICES FOR DUCT SILENCERS

C. Prepare and place systems into service.

D. Inspect installation periodically.

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E. Lag ductwork, where indicated by wrapping with insulation and covering. Apply covering to be air tight. Do not attach covering rigidly to ductwork.

F. Attach ductwork to acoustic louvers with flexible duct connections. Refer to Section 15910 - Ductwork Accessories.

G. Provide services of NEBB testing agency to take noise measurement. Use meters meeting requirements of ASA 47 (ANSI S1.4).

H. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations, as directed.

I. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements.

J. Submit complete report of test results including sound curves.

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 233300

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SECTION 23 64 11 - PACKAGE WATER CHILLERS - RECIPROCATING, SCROLL, AND SCREW

PART 1 GENERAL

1.1 SUMMARY

System Description: Chiller shall incorporate Scroll-type compressors and consist of multiple 165-ton modules. Each module shall consist of (2) tandem compressor sets, and common dual circuit condenser, dual circuit evaporator, thermal expansion valves, and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit chiller must be able to produce chilled water even in the event of a failure of one or more refrigerant circuits. Circuits shall not contain more than 51 lb. of R-410a refrigerant.

A. Related Sections:
   1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
   2. Section 23 01 00 – Basic Mechanical Methods: Methods and procedures for mechanical work.
   3. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
   4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
   5. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for chillers specified in this section.
   6. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and condenser water piping for placement by this section.
   7. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for piping specialties for placement by this section.
   8. Section 23 23 00 - Refrigerant Piping: Product requirements for refrigerant piping for placement by this section.
   9. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for connection to chillers specified by this section.

1.2 REFERENCES

A. Air-Conditioning and Refrigeration Institute:
   1. ARI 550/590 - Water Chilling Packages Using the Vapor Compression Cycle.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
   1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

C. American Society of Mechanical Engineers:
   1. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

D. National Electrical Manufacturers Association:
   1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

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1.3 DEFINITIONS

A. Coefficient of Performance (COP) - cooling: The ratio of the rate of heat removal to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.

B. Integrated Part-Load Value (IPLV): A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.

1.4 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Shop Drawings: Indicate components, assembly, dimensions, weights and loads, required clearances, and location and size of field connections. Indicate valves, strainers, and thermostatic valves required for complete system.

C. Product Data: Submit rated capacities, weights, specialties and accessories, electrical requirements, wiring diagrams, and control diagrams.

D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include startup instructions.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements including those furnished but not produced by manufacturer.

F. Manufacturer’s Field Reports: Submit start-up report for each unit. Indicate results of leak test and refrigerant pressure test.

G. Requests for Information and Submittals
   1. Requests for Information:
      a. All RFIs are required to be in electronic format.
      b. Send all RFIs to submittals@swansonrink.com.
         1) RFIs that are larger than 10MB should be reviewed for other possible means for electronic transfer – sharefile, sharepoint, FTP, etc.
      c. Include the project title and RFI number in the e-mail subject line.
   2. Submittals:
      a. All Submittals are required to be in electronic format.
      b. Send all submittals to submittals@swansonrink.com.
         1) Submittals that are larger than 10MB should be reviewed for other possible means for electronic transfer – sharefile, sharepoint, FTP, etc.
      c. Include the project title and Submittal number in the e-mail subject line.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Submit start-up instructions, maintenance data, parts lists, controls, and accessories. Include trouble-shooting guide.

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1.6 QUALITY ASSURANCE

A. Conform to ARI 550/590 code for testing and rating of scroll water chillers.

B. Chiller is required to be run tested at manufacturer's facility to job specific requirements, prior to shipment. Report available upon request.

C. Performance Ratings: Coefficient of Performance (COP) and Integrated Part-Load Value (IPLV) not less than prescribed by ASHRAE 90.1.

D. Perform Work in accordance with authority having jurisdiction.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Accept chillers on site in factory packaging. Inspect for damage.

C. Protect indoor chillers from weather by storing under roof.

D. Chiller(s) shall be delivered to the job site completely assembled and charged with complete refrigerant charge.

E. Installing contractor to comply with the manufacturer's instructions for transporting, rigging, and assembly of chiller.

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

B. Furnish five year manufacturer warranty to include coverage for complete assembly including materials and labor.

1.11 MAINTENANCE SERVICE

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.

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B. Furnish service and maintenance of chiller for one years from Date of Substantial Completion.

C. Examine unit components bi-monthly. Clean, adjust, and lubricate equipment.

D. Include systematic examination, adjustment, and lubrication of unit, and controls checkout and adjustments. Repair or replace parts in accordance with manufacturer's operating and maintenance data. Use parts produced by manufacturer of original equipment.

E. Perform work without removing units from service during building normal occupied hours.

F. Provide emergency call back service during working hours for this maintenance period.

G. Maintain locally, near Place of the Work, adequate stock of parts for replacement or emergency purposes. Have personnel available to ensure fulfillment of this maintenance service, without unreasonable loss of time.

H. Perform maintenance work using competent and qualified personnel under supervision and in direct employ of manufacturer or original installer.

I. Do not assign or transfer maintenance service to agent or subcontractor without prior written consent of Owner.

PART 2 PRODUCTS

2.1 PACKAGED WATER CHILLERS

A. Manufacturers:
   1. Multistack.
   2. Substitutions: Not Permitted.

B. Product Description: Factory assembled and tested, packaged, water cooled, liquid chillers consisting of scroll compressors, compressor motor, condensers, evaporator, refrigeration accessories, instrument and control panel including gages and indicating lights, auxiliary components and accessories, and motor starters.

C. Scroll Compressors:
   1. Unit: Direct drive, hermetic, 3600 RPM, fixed compression, scroll motor-compressor with control panel.
   2. Features: Centrifugal oil pump, sump oil heater, oil level sight glass, oil charging valve, two point lubrication for each motor bearing, flooded lubrication for journal and thrust bearings, check valve on scroll discharge port.
   3. Motor: Suction-gas cooled, hermetically sealed, squirrel cage induction.
   4. Automatic Capacity Reduction: Wire steps to terminal strip.

2.2 EVAPORATOR

A. Each evaporator shall be brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig refrigerant working pressure and 325 psig working water pressure on the evaporator. Evaporator heat exchanger shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

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B. Design, test, and stamp refrigerant side for 225 psig working pressure and water side for 150 psig working pressure, in accordance with ASME Section VIII.

C. Insulate with 0.75 inch minimum thick flexible expanded polyvinyl chloride insulation with maximum K factor of 0.28.

D. Furnish water drain connection and thermometer wells for temperature controller and low temperature cutout.

2.3 CONDENSERS

Each condenser shall be brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig refrigerant working pressure and 650 psig working refrigerant pressure and 325 psig working water pressure on the condenser. Condenser heat exchanger shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

A. Furnish 450 psig safety relief valve on condenser shell.

B. Design, test, and stamp water side for 150 psig working pressure in accordance with ASME Section VIII.

2.4 Variable Flow Operation - Chilled and/or Condenser Water

A. Butterfly type isolation valves shall incorporate appropriate accessories and controls to allow the chiller to operate efficiently in a variable primary flow system. Valve shall modulate via a motorized actuator for leaving water temperature control, chiller minimum flow bypass, chiller no load bypass, or head pressure control. Compressor staging based off of return water temperature is not acceptable for temperature control.

B. Compressor: Each module shall contain two compressor sets, each set containing two compressors, with the two compressors in the set manifolded together and mounted to the module with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure safety cut-outs.

C. Central Control System.
   1. Scheduling of the various compressors shall be performedby a microprocessor based control system (Master Controller). A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.
   2. The Master Controller shall monitor and report the following on each refrigeration system:
      a. Discharge Pressure Fault
      b. Suction Pressure Fault
      c. Compressor Winding Temperature
      d. Suction Temperature
      e. Evaporator Leaving Chilled Water Temp.
   3. The Master Controller shall be powered by the chillers single point power connection and shall monitor and report the following system parameters:
      a. Chilled Water Entering and Leaving Temperature
      b. Condenser Water Entering and Leaving Temperature
      c. Chilled Water and Condenser Water Flow
   4. An out of tolerance indication from these controls or sensors shall cause a “fault” indication at the Master Controller and shutdown of that compressor with the transfer of load

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requirements to the next available compressor. In the case of a System Fault the entire chiller will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller's 2 line by 40 character back-lit LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).

5. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freeze-up.
6. The control system shall monitor entering and leaving chilled water temperatures to determine system load and select the number of compressor circuits required to operate. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to optimize the chiller performance to different existing building loads.

D. INTEROPERABILITY WEB PORTAL
   1. The Chiller shall be capable of interfacing to a building automation system. Interface shall be accomplished using an Interoperability Web Portal and shall be capable of communication over BACNet, .

E. Fail to Run Mode (FRM)
   1. Chiller shall be capable of operation in the event that the Master Controller has lost communication. FRM provides the ability to switch the chiller into manual mode automatically keeping the chiller online until a replacement Master Controller can be provided. FRM requires a power phase monitor per module.
   2. IFM flow-switch per module. Integral to each module and powered by the module for individual module proof of flow and flow safety. Modules without independent IFM switches per module are not acceptable alternates.

F. Chiller shall have a single point power connection and external inputs and outputs to be compatible with the building management system. Inputs/Outputs include:
   1. Remote Start/Stop
   2. Customer Alarm Relay
   3. Customer Chilled/Load Limit Reset Signal
   4. ECW to Mechanical Cooling Module
   5. LCW from Mechanical Cooling Module
   6. ECHW to Mechanical Cooling Module
   7. LCHW from Mechanical Cooling Module
   8. Power Phase Monitor
   9. Chilled Water Flow Switch Input
   10. Condenser Water Flow Switch Input
   11. Full Load Indicator Relay
   12. Condenser Pump Relay
   13. DDRS Condenser Multiflush Relay
   14. Chilled Water Pump Relay

G. Each inlet water header shall incorporate a built in 30-mesh (maximum) in-line strainer system to prevent heat exchanger fouling and accommodate 100% flow filtration with a minimum surface area of 475 sq inches per module. Condenser-side strainer system shall incorporate an automatic debris blow-down system for self-cleaning of the strainer system that is controlled and powered by the chiller.

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H. Power: Chiller shall be equipped with a pre-engineered genuine electrical system for single point power rated at a 5,000 amp SCCR. Where the equipment size exceeds the amp rating of the electrical system, multiple power connections may be applied. Pre-engineered system shall also incorporate individual module isolation circuit breakers for full redundancy and ability of a module to be taken off-line for repair while the rest of the modules continue to operate. Individual power feeds to each module shall be unacceptable.

I. IFM flow switch per module. Integral to each module and powered by the module for individual module proof of flow and flow safety. Modules without independent IFM switches per module are not acceptable alternates

2.5 REFRIGERANT CIRCUIT

A. Factory furnished and piped.

B. Furnish for each refrigerant circuit:
1. Liquid line solenoid valve.
2. Filter dryer (replaceable core type).
3. Liquid line sight glass and moisture indicator.
4. Thermal expansion for maximum operating pressure.
5. Charging valve.
6. Insulated suction line.
7. Discharge line check valve.
8. Compressor discharge service valve.
9. Pressure relief device.

2.6 CONTROLS

A. On or near chiller, mount steel control panel with NEMA 250 Type 1 enclosure, containing starters, power and control wiring, molded case disconnect switch, factory wired with single point power connection.

B. For each compressor, furnish across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for control power. Furnish manual reset, current overload protection.

C. Furnish devices on control panel face:
1. Compressor, run lights.
2. System start-stop switch.
3. Control power fuse of circuit breaker.
4. Compressor lead-lag switch.
5. Demand limit switch.

D. Furnish safety controls arranged so machine is shut down and requires manual reset:
1. Low evaporator refrigerant pressure
2. Loss of flow through the evaporator
3. Loss of flow through the condenser
4. High condenser refrigerant pressure
5. High compressor motor temperature
6. Low suction gas temperature
7. Low leaving evaporator water temperature.
8. Flow switch in chilled water line.

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9. Flow switch in condenser water line.
10. Relay for remote mounted emergency shutdown.

E. Furnish the following operating controls:
1. The chiller shall be furnished with a Master Controller as an integral portion of the chiller control circuitry to provide the following functions:
a. Provide automatic chiller shutdown during periods when the load level decreases below the normal operating requirements of the chiller. Upon an increase in load, the chiller shall automatically restart.
b. Provisions for connection to automatically enable the chiller from a remote energy management system.
c. The control panel shall provide alphanumeric display showing all system parameters in the English language with numeric data in English units.
d. Each module shall contain a slave controller that will allow any module to run in the event of a master controller failure or loss of communication with the master controller via an on/off/manual toggle switch.

F. Normal Chiller Operation
1. When chiller is enabled, the factory supplied Master Controller stages the chiller capacity from minimum to maximum as required by building load.
The Chiller control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.

G. Power Phase Monitor (PPM)
1. Provide a Power Phase Monitor on the incoming power supply to the chiller. This device shall prevent the chiller from operating during periods when the incoming power is unsuitable for proper operation.
2. The Power Phase Monitor shall provide protection against the following conditions:
a. Low Voltage (Brown-Out)
b. Phase Rotation
c. Loss of Phase
d. Phase Imbalance

PART 3 EXECUTION

3.1 INSTALLATION

A. Install indoor chiller on concrete housekeeping pad minimum 3-1/2 inches high and 6 inches wider than equipment base on each side. Refer to Section 03 30 00.

B. Install packaged outdoor chiller on concrete foundation minimum 6 inches thick and 6 inches wider than equipment base on each side. Refer to Section 03 30 00.

C. Install units on vibration isolation. Refer to Section 23 05 48.

D. Install the following piping accessories on evaporator chilled water piping connections. Refer to Section 23 21 16 and Section 23 21 13.
1. On inlet:
a. Thermometer well for temperature controller.
b. Thermometer.
c. Strainer.

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d. Flow switch.
e. Flexible pipe connection.
f. Pressure gage.
g. Shut-off valve.

2. On outlet:
a. Thermometer.
b. Flexible pipe connection.
c. Pressure gage.
d. Shut-off valve.

E. Install auxiliary water piping for oil cooling units and purge condensers.

F. Install the following piping accessories on condenser water piping connections.
1. On inlet:
a. Thermometer well for temperature limit controller.
b. Thermometer well and thermometer.
c. Strainer.
d. Flow switch.
e. Flexible pipe connection.
f. Pressure gage.
g. Shut-off valve.
2. On outlet:
a. Thermometer well and thermometer.
b. Flexible pipe connection.
c. Pressure gage.
d. Shut-off valve.

G. Arrange piping for easy dismantling to permit tube cleaning.

H. Install refrigerant piping connections to air-cooled condensing units. Refer to Section 23 23 00.

I. Install piping from chiller safety relief valve to outdoors. Size as recommended by manufacturer.

J. Install chiller accessories furnished loose for field mounting.

K. Install electrical devices furnished loose for field mounting.

L. Install control wiring between chiller control panel and field mounted control devices.

M. Provide connection to electrical service. Refer to Section 26 05 03.

3.2 PIPING SYSTEM FLUSHING PROCEDURE

A. Prior to connecting the chiller to the condenser and chilled water loop, the piping loops shall be flushed with a detergent and hot water (110-130° F) mixture to remove previously accumulated dirt and other organics. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants

B. During the flushing 30 mesh (max.) Y-strainers (or acceptable 3.3 Equivalent) shall be in place in the system piping and examined periodically as necessary to remove collected residue. The use of on board chiller strainers shall not be acceptable. The flushing process shall take no less than 6 hours or until the strainers when examined after each flushing are clean. Old systems

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with heavy encrustation shall be flushed for a minimum of 24 hours and may take as long as 48 hours before the filters run clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturer's instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.

C. Prior to supplying water to the chiller the Water Treatment Specification shall be consulted for requirements regarding the water quality during chiller operation. The appropriate chiller manufacturer's service literature shall be available to the operator and/or service contractor and consulted for guidelines concerning preventative maintenance and off-season shutdown procedures.

3.3 FIELD QUALITY CONTROL

A. Section [01 40 00 - Quality Requirements] [01 70 00 - Execution and Closeout Requirements]: Field inspecting, testing, adjusting, and balancing.

B. Furnish cooling season start-up, winter season shutdown service, for first year of operation. When initial start-up and testing takes place in winter and machines are to remain inoperative, repeat start-up and testing operation at beginning of first cooling season.

3.4 MANUFACTURER'S FIELD SERVICES

A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.

B. Furnish services of factory trained representative for minimum of one days to leak test, refrigerant pressure test, evacuate, dehydrate, charge, start-up, calibrate controls, and instruct Owner on operation and maintenance.

C. Furnish initial charge of refrigerant and oil.

3.5 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.

3.6 DEMONSTRATION AND TRAINING

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.

B. Demonstrate system operations and verify specified performance. Demonstrate low ambient operation during winter testing for air-cooled condensers.

END OF SECTION

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SECTION 236600 - PRECONDITIONED AIR HYDRONIC AIR HANDLING UNITS - AVIATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes hydronic units, supplied with chilled water from a chiller system.

B. Related Sections:
1. Section 236613 "Preconditioned Air Ductwork and Accessories - Aviation" for ductwork and accessories.
2. Section 236616 "Preconditioned Air Electric Control Systems - Aviation" for electric control systems.
3. Section 236619 "Preconditioned Air Sequence of Operation - Aviation" for sequence of operation.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of hydronic air handling unit.

1. Product data for selected models, including specialties, accessories, and the following:

a. Fan performance curves with system operating conditions indicated.
b. Motor ratings and electrical characteristics plus motor and fan accessories.
c. Materials thicknesses and finishes.
d. Dampers, including housings, linkages, and operators.
e. Submit air filter manufacturer's technical product data including dimensions, weights, required clearances and access, flow capacity including initial and final pressure drop at rated air flow, efficiency and test method, fire classification, and installation instructions.

2. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.

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C. Wiring diagrams that detail power, signal, and control wiring.

1. Differentiate between manufacturer installed wiring and field installed wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates, signed by manufacturers of air handling units, certifying that their products comply with specified requirements.

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic air handling units to include in emergency, operation, and maintenance manuals.

B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.6 QUALITY ASSURANCE

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

B. ARI Compliance: Air filter equipment shall comply with ARI 850.

C. NFPA Compliance: Comply with applicable portions of NFPA 70, for components and installation of air handling units.

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. UL Compliance: Components shall be UL listed and labeled.

1.7 DELIVERY, STORAGE. AND HANDLING

A. Lift and support units with the manufacturer's designated lifting or supporting points.

B. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.

C. Deliver fan units as a factory assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

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D. Store all equipment and material in suitable facilities until delivery and acceptance by the Owner.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace heat exchanger of hydronic air handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Minimum two (2) years from date of Substantial Completion.

1.9 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Handling Units:

a. Twist, Inc.
b. or approved equal.

2. Air Filters:

a. American Air Filter Company.
b. Farr Company.
c. Research Products Corp.
d. or approved equal.

2.2 FANS

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with required capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel designed to operated at no more than 70 percent of the first critical speed at the top of the speed range of the fan's

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class.

C. Shaft Bearings: Provide bearings having a median life "Rating Life" (ABMA L50) of 200,000, calculated in accordance with ABMA 9 for ball bearings or ABMA 11 for roller bearings.

D. Factory Finish:

1. Sheet Metal Parts: Prime coating prior to final assembly.
2. Exterior Surfaces: Manufacturer's standard finish is acceptable.

2.3 AIR FILTERS

A. Provide [**throw away**] type air filters in the PCA air handling units.
1. Throw Away Air Filters: Provide factory fabricated, dual filter system, consisting of a 25 mm fiberglass media prefilter, and a 100 mm 30/30 woven cotton fabric main filter. Provide filters with rated face velocity of 2.5 M/sec, initial resistance not greater than 24.9 Pa, and average arrestance of 75 percent.

2.4 AIR HANDLING UNIT AND SUPPLY AIR SYSTEM

A. The system and all components shall be designed and constructed in accordance with all codes, standards, local laws, and regulations applicable to the design and construction of this type of equipment.

B. Units shall be factory fabricated and factory tested, and all components shall be UL listed.

C. Provide compact, lightweight, and low noise insulated air handling units that can be mounted on the passenger loading bridge, such that bridge movement is unrestricted on apron drives. Air handling unit shall be mounted underneath bridge at rotunda or the cab. Unit shall be free of vibration transmission and installed with vibration isolators when necessary. The air handling unit at each gate shall contain cooling coils, blower, inlet vane damper (or inlet butterfly damper), auxiliary electric strip heater (for use when central plant(s) are still in the dedicated cooling season, minimal heating, only), and controls to provide the required cool air, heated air, or ventilation to maintain the aircraft cabin temperature specified. Maximum air handler weight shall not exceed 1360 Kg, including accessories, mounted at the rotunda or on the bridge behind the lift column.

1. The air handling unit(s) to be provided at each gate shall be of the "Type" as scheduled on the drawings. Per schedule listed above, AHU's shall have the capacity to sufficiently cool the largest designated aircraft parked at each bridge (see note below) as indicated on plan drawings, considering quantity of air to be delivered and static pressures as scheduled in following paragraphs of this Article. Units serving wide body gates shall also operate properly when serving a narrow body aircraft at the same gate. Units serving B 747 / A340 gates shall also operate properly when serving a wide body or narrow body aircraft.

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Submittals shall indicate the actual M 3/hr at the minimum and maximum static pressure conditions and list the kW input at each condition. (Note: Two wide body AHU's may be used to serve one B 747, A340 or B 777. Refer to plans for bridge and aircraft locations. Some narrow-body gates may have wide body AHU's for that purpose.)

2. Airflow shall be controlled with an inlet vane damper (or inlet butterfly damper) on the blower interfaced with a thermostat. Variable frequency drive, as a method of airflow control, is also acceptable. The blower shall be centrifugal type and sized for the appropriate variable volume airflow requirements. The unit size shall be selected so that the fan brake horsepower does not exceed the maximum required over the design operating range of the unit at the total static pressure.
3. External static pressure shall be defined as the static pressure at the outlet of the air handling unit. The Contractor shall present the external static pressure of each type air handling unit on the appropriate equipment data sheet. An estimate of static pressure available at the aircraft connection, on a per gate basis, shall also be presented with the submittal.
4. Horsepower shall be selected based on the Contractor's choice of equipment that affects the external resistance of the system. However, the minimum nominal motor rating requirement for a narrow body air handling unit shall be 11.19 kW (15 hp); a wide body air handling unit shall be 18.65 kW (25 hp); and for a B 747 / A340 air handling unit 37.3 kW (50 hp). Contractor shall furnish the fan motor and unit size adequate for static pressure and maximum brake horsepower requirements.
5. The AHU shall be provided with motor starter equipment.
6. Return air to the unit shall not be utilized.
7. The Contractor shall submit correspondence with the bridge manufacturer indicating coordination efforts to maintain structural integrity of the bridge.
8. The construction of the unit shall be of a material sufficient to provide adequate structural rigidity of frame and enclosure; of a noncorrosive nature; and provided with thermal insulation for conditions encountered in normal usage. Equipment exterior shall be primed and painted to match bridge color. Equipment interior shall be painted per manufacturer's standard color.
9. Provide and install hooks on any service and cable boxes (both sides) as required to meet OSHA standards and Owner's safety system. Provide maintenance instruction on the correct method of servicing all bridge mounted equipment.
10. If the air handling unit is to be mounted underneath a fixed bridge, a minimum of four guard posts shall be mounted on the apron around the unit for protection.
11. The maximum sound level for the air handling unit(s) at maximum cooling shall not exceed 85 dBA at a distance of 5 M from the unit. Sound power level radiated by the unit outlet and at the unit inlet when the unit is operated at the designated capacity shall be furnished with the submittal.
12. Coil(s) shall be copper finned copper tube. The number of tubes and fin spacing shall be submitted on coil selections made. Coils shall be constructed and certified in accordance with ASHRAE 15 and ARI 410. Furnish drainable coils. Galvanized casing shall be the manufacturer's standard. Design coils for a working pressure of 862 kPa. Hydrostatically test at 2758 kPa and air test at 1379 kPa under water.
13. Capacity control and defrost control shall be identified and explained in submittal.

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14. Provide access doors of the hinged and insulated type. Locate as required for proper access to the following:

    a. Dampers.
    b. Filters.
    c. Coils.

D. A drain pan shall be provided for each AHU. A condensate Pump shall be required in each AHU where the gate configuration does not allow for gravity drain to a potable water ramp drain. The condensate pump shall be lightweight, self priming, and capable of running dry without damage. Minimum pump rating shall be 0.2 L/sec, 13 M head, with suitable horsepower rating.

1. Position the drain pan under the coil section. Drain pan shall be stainless steel. Condensate pump shall be provided with a summer/winter switch or internal float switch actuated assembly.

E. Controls shall include, but are not limited to a remote "start/stop" push button station accessible from the ground level for each AHU.

1. BACnet Wireless IP via Loytec BACnet IP wireless Router the DEN EMCS to monitor, view, and control all points. Wiring, Conduit and interface shall be included with PC Air unit and coordinated with other components.

F. A narrow body air handling unit shall be capable of delivering a minimum of 68 Kg/min of 1.7 degrees C air at 2488 Pa total pressure at the end of the aircraft air hose nozzle through 18 M of air hose at sea level. Provide a 20 kW auxiliary electric strip heater. The air handling unit provided in this contract shall be designed appropriately to compensate for operating conditions at installation altitude. The supply air pressure shall not exceed the aircraft manufacturer's maximum inlet pressure.

G. A wide body air handling unit shall be capable of delivering a minimum of 110 Kg/min of 0 degrees C air at 5473 Pa total pressure at the end of the aircraft hose nozzle through 18 M of air hose at sea level. Provide a 40 kW auxiliary electric strip heater. The air handling unit provided in this contract shall be designed appropriately to compensate for operating conditions at the installation altitude.

2.5 MOTORS

A. Provide motors in accordance with Division 26 sections.

B. Starters, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26.

2.6 CONTROL SYSTEMS

A. Refer to Section 236619 "Preconditioned Air Electric Control Systems" for controls requirements.

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PART 3 - EXECUTION

A. FACTORY TEST OF AIR HANDLING UNITS

B. Factory test each air handling unit prior to shipment. Test each unit in accordance with the following procedure and submit a record of the results of each test identifying the unit number of each data set.

C. Apparatus: Static pressure, either external or total, shall be measured with a U tube manometer. The manometer must have graduations no larger than 5.0 Pa from zero to 500 Pa, and graduations no larger than 50 Pa from 500 Pa up.

1. Volume flowrate shall be measured by static pressure drop across ASME long radius nozzles. The nozzles shall be housed in a multiple nozzle airflow chamber, which is built and operated in accordance with AMCA Standard 210 85, "Laboratory Methods of Testing Fans for Rating". The manometer used to measure the pressure drop must have a demonstrated accuracy of 2.5 Pa.
2. Air density shall be determined with wet and dry bulb thermometers and a mercury barometer, or the equivalent. An ammeter, voltmeter, and tachometer shall be employed.

D. Procedure: The central station air handler will be connected to the flow chamber and sealed well. The fan unit will be started and allowed to run for at least five minutes. A static pressure load shall be exerted on the fan by dampering or blocking the inlet or outlet. In the case of specified total pressure, the static taps should be placed on either side of the fan wall. In the case of specified external pressure, the static taps should be placed on the inlet and outlet of the cabinet.

1. Static pressure and hence flowrate shall be measured at least at three points. One at a static load near design, one slightly above, and one slightly below. This will yield a short curve intersecting the system curve.
2. Motor amperage draw, line voltage, and fan RPM shall be measured for each performance point.
3. Using the measured density, results shall be corrected to standard conditions or to conditions at job site. Results shall be plotted for comparison to specifications. A central station air handler is considered acceptable when the volume flowrate is at between 97.5 percent and 102.5 percent of design, when evaluated along the specified system curve and the motor amperage draw does not exceed nameplate amperes. Owner's Representative shall be notified five (5) days prior to test.

3.2 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of air handling units.

B. Do not proceed until unsatisfactory conditions have been corrected.

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3.3 INSTALLATION

A. PCA air handling units shall be mounted underneath the bridge at the rotunda or the cab.

B. Arrange installation of units to provide access space around air handling units for service and maintenance.

C. Furnish all necessary supports, brackets, guard posts, safety hooks, etc., for properly installing all air handling units.

D. All air handling units shall be properly aligned, adjusted, and lubricated before final acceptance.

E. Perform water and air system testing and balancing as specified in Section 230593 "Testing, adjusting, and Balancing for HVAC".

3.4 CONNECTIONS

A. Duct installations and connections are specified in other Sections. Make final duct connections with flexible connections.

B. Electrical Connections: The following requirements apply:

1. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
2. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" in compliance with the National Electrical Code.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to assist Contractor and test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Inspect the field assembly of components and installation of air handling units including ductwork and electrical connections.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Test Reports: Prepare a written report to record the following:

    a. Test procedures used.
    b. Test results that comply with requirements.
    c. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

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C. Hydronic air handling units will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to assist Contractor and train Owner's maintenance personnel to adjust, operate, and maintain oil-fired unit heaters.

1. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

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 236600

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SECTION 236616 - PRECONDITIONED AIR ELECTRIC CONTROL SYSTEMS - AVIATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Requirements:
1. Section 236600 "Preconditioned Air Hydronic Air Handling Units - Aviation" for hydronic air handling units.
2. Section 236619 "Preconditioned Air Sequence of Operation - Aviation" for sequence of operation.
3. Electrical work shall be as specified in Division 26.
4. Control sequences are specified Section 236619 "Preconditioned Air Sequence of Operation - Aviation".
5. Installation of instrument wells and valve bodies in mechanical systems: Other Division 23 Sections as applicable.
6. For the following work: Division 26 Sections as applicable:

    a. Power supply wiring for power source to power connection on controls and/or unit control panels. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory installed, by manufacturer.
    b. Interlock wiring between electrically operated equipment units; and between equipment and field installed control devices. Interlock wiring specified as factory installed is work of this Section.

7. Provide the following electrical work as work of this Section, complying with requirements of Division 26 Sections:

    a. Control wiring between field installed controls, indicating devices, and unit control panels.

1.2 SUMMARY

A. Section includes control panels and all related components, controls, and devices to complete the systems specified herein.

B. General:

1. Contractor shall furnish all design drawings and detailed submittal data corresponding to the complete control system included as part of the Preconditioned Air design. Drawings and specifications are to indicate general arrangement of the equipment, controls, and devices, types of control schemes,

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and the extent of remote controls as required to make the complete system meet the performance specifications.

2. Systems Included:

   a. Preconditioned air central chiller plant(s) system.
   b. Ramp air handling systems.
   c. The direct digital control system.

3. Type of Control System: Electronic sensing electric or electronic positioning.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of preconditioned air electric control system.

1. Submit manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and including installation instructions and start up instructions.

   a. Furnish description or specification sheets on all control components.
   b. Submit samples of all control system graphic maps to be created or modified with all points to be used.

2. Include data substantiating that materials comply with requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For preconditioned air electric control systems to include in emergency, operation, and maintenance manuals.

B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of electric control equipment, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Codes and Standards:

1. Electrical Standards: Provide electrical products, which have been tested, listed, and labeled by UL and comply with NEMA standards; except AHUs, which shall

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have, components listed and labeled by UL, or shall be Owner approved.

2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.
3. NFPA Compliance: Comply with NFPA 90A where applicable to controls and control sequences.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protected from weather.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace preconditioned air electric control system that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Minimum two (2) years from date of Substantial Completion.

1.8 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. OEMCtrl
2. ALC
3. or approved equal.

2.2 MATERIALS AND EQUIPMENT

A. General: Provide BACnet OEMCtrl certified electric control products in sizes and capacities required, consisting of valves, dampers, thermostats, clocks, sensors, controllers, and other components as required for complete installation. Provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer. Provide electric control systems with all specified functional and construction features. Devices

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shall communicate wirelessly via the Loytec LIP-ME201C BACnet router with the LWAN-800 wireless adaptor to communicate with existing DEN Honeywell Building Solutions Facility Management System (FMS). All programming shall be accessible and backed up on the DEN ALC server.

B. Control Valves: Provide factory fabricated electrical control valves of type, body material and pressure class as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system. Provide valves which mate and match material of connecting piping. Equip control valves with control valve motors, and with proper shutoff ratings for each individual application.

1. Water Service Valves: Equal percentage characteristics with rangeability of 50 to 1, and maximum full flow pressure drop of 35 kPa.
2. Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
3. Double Seated Valves: Balanced plug type, with cage type trim providing seating and guiding surfaces for plugs on "top and bottom" guided plugs.
4. Valve Trim and Stems: Polished stainless steel.
5. Packing: Spring loaded Teflon, self adjusting.
6. Air Handling Unit Control Valves: Provide control valves for control of air handling units that are of integral motor type. Provide 2 position or modulating type valves, electrically actuated by line voltage of 24 V.

2.3 SPACE TEMPERATURE CONTROL ASSEMBLY - BRIDGE SERVICE

A. Furnish a temperature sensor (probe), which can be placed by gate agents in the aircraft interior. This probe shall sense the aircraft space temperature and control the aircraft space temperature automatically.

2.4 RELAYS

A. Electrical relays shall be approved industrial type with NEMA 12 general purpose enclosures and multiple contacts as required.

B. All relays shall be 220 volts or less.

C. All relays shall have A600 contact rating.

D. All relays shall have two spare contacts (1 N.O. and 1 N.C.)

2.5 ELECTRONIC - ELECTRIC PROPORTIONAL OPERATORS

A. Operators shall have single phase 220 volt or 24 volt heavy duty motors and sealed oil immersed gear train.

B. Operators shall modulate the controlled device without exceeding the torque rating of

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the motor.

C. Furnish integral spring return to permit fail safe operation upon power interruption.

D. Provide built in, adjustable, auxiliary switches where required.

E. Furnish complete with mounting brackets, control arms, linkage, and cranks.

2.6 TEMPERATURE INDICATOR AND SELECTOR SWITCHES

A. Control panel mounted electronic precision temperature indicators and selector switches may be used in lieu of control panel mounted dial temperature gauges.

B. Sensing elements: Wire wound resistance temperature elements.

C. Provide automatic compensation for ambient temperature variations.

D. Minimum calibrated accuracy shall be 1 percent of full scale range.

E. Minimum scale length shall be adequate to provide 1 degree division and a range of approximately -10 to 50 degrees C.

F. Temperature indicator readings shall not be affected by a supply voltage variation of plus or minus 10 percent line voltage fluctuation.

G. Maximum response time shall be 6 seconds for full scale deflection.

H. Selector switches shall be panel mounted momentary contact push button type with approved type nameplates.

2.7 MOTORIZED VALVE ASSEMBLIES - INTERIOR EQUIPMENT AREAS

A. Assemblies shall include the following:

1. Electronic or electric operators as specified in this Section.
2. Adjustable linkage.
3. Position indicators.

B. Valve bodies for up to 105 degrees C water service. Bodies shall be as follows:

1. Have adequate flow coefficient Cv for the application and as indicated.
2. Suitable for the temperatures and fluid handled.
3. Provide tight shutoff if single seated.
4. Bronze with screwed ends up to 65 mm.
5. 125 pound cast iron flanged in sizes over 65 mm, unless otherwise indicated due to higher pressures.

C. Control valve operators shall be adequate to close valves completely against the

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maximum shutoff pressure of the system.

2.8 ELECTRICAL AND ELECTRONIC CONTROL DEVICES

A. Switches, potentiometers, and other control components shall be rated at 220 volt service and have suitable dustproof enclosures equal to NEMA 12 general purpose. Provide indicating plates, and identifying nameplates unless otherwise specified.

B. Transformers shall be furnished as required with enclosed terminals and adequate ratings for use with 220 volt ac primary supply voltage.

C. Outdoor control devices shall have NEMA 4 weathertight enclosures. Electrical devices installed in hazardous AREAS shall have enclosures approved for the NEC classification.

D. Water Flow Switches: Provide water flow switches of stainless steel or bronze paddle types. Where flow switches are used in chilled water applications, provide vapor proof type to prevent condensation of electrical switch. Provide pressure flow switches of bellows actuated mercury type or snap acting type, with appropriate scale range and differential adjustment for service indicated.

E. Local Control Panels: Panels shall be manufacturer's standard, completely enclosed, wall mounted cubicle panels. Control arrangement shall be approved by the Construction Supervisor.

1. Fabricate panels of 1.9 mm furniture quality steel, or 6063 T5 extruded aluminum alloy, totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop painted finish and color. Provide UL listed cabinets for use with line voltage devices.
2. Panel Mounted Equipment: Include temperature and humidity controllers, relays, and automatic switches, except exclude low temperature protection thermostats, firestats, and other devices excluded in sequence of operation. Fasten devices with adjustments accessible through front of panels. Also include manual switches, including damper "minimum off" positioning switches, "summer-winter" switches, and "manual automatic" switches; and including dial thermometers.
3. Nameplates: Furnish for all components located on the front of the panel. Nameplates shall be sizes, materials, and contain legends consistent with Contractor's standard practice.
4. Terminal Block: Furnish for all electrical connections. Identify terminals.
5. Control Panel Wiring: Wiring shall be as specified in Division 26. Control panels shall be prewired at the factory to terminal strips for field connections. Factory test all wiring. Wiring terminals shall be arranged for top rear control cable connections unless otherwise specified or required. Connect terminal blocks with approved flexible panelboard wiring to electrical control switches and devices mounted on the hinged door. Wiring shall be neatly arranged and supported in plastic or plated steel brackets.

F. Central (Master) Control Panels: Provide central control panels of fully enclosed steel cubicle type, with locking doors and/or locking removable backs. Match finish of panels

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and provide multi-color graphic displays, schematically showing system being controlled.

G. Central Plant Control System: Refer to Section 15495 Preconditioned Air Sequence of Operation for PCA System Computer Control.

H. Provide battery backup for all memory devices.

2.9 UNITARY CONTROLLERS

A. General: Unitary DDC controllers (UCs) shall be standalone, EEPROM-based, configured to perform the sequences specified, and I/O selected for the application. All unitary DDC controllers (UCs) shall be BACnet-approved products and shall support the BACnet Functional Profile for the given application. UC s shall be tested and listed under UL916 for computing devices. UC enclosures shall be flame retardant, compact plastic conforming to UL94-V5 for plenum mounting or plated steel. UCs shall be CE approved and meet FCC Part 15 class B requirements. UC s shall be configured for DIN rail mounting, using industry-standard clip-on adapters, or for direct panel mounting. Each ASC shall be capable of standalone operation and shall continue to provide control functions without being connected to the network. Each ASC will contain sufficient I/O capacity to control the target system.

B. Communication: PC Air controller shall communicate to the Loytec BACnet WIFI IP router at 38.8k baud via BACnet MS/TP. Both Controller and router shall be mounted in the PC Air Control Cabinet. The duel WIFI Antennas cabling shall be provided to allow for installation on either side of the unit to achieve the strongest WIFI connection.

1. PRODUCT DATA SHEET 2 - Controller shall communicate to BAS remote server via wireless transceiver:

    a. Loytec BACnet MSTP/IP Wireless Router.
    b. Device Specifications:

        1) 802.11b/g wireless interface.
        2) One BACnet MS/TP port
        3) Wireless security with IEEE 802.11i-pSK, WPA-PSK, TKIP protection.
        4) 256-bit AES, end-to-end encryption.
        5) Complete with power supply.

C. Environment: The hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for ambient temperature operation at -40 degrees C to +65 degrees C (-40 degrees F to +150 degrees F) and ambient humidity of 5 to 95 percent RH noncondensing.
2. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for ambient temperature operation at 0 degree C to +50 degrees C (32 degrees F to +122 degrees F) and humidity of 5 to 95 percent RH

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noncondensing.

D. Serviceability: Each UC shall be provided with face-mounted LED type annunciation to continually display its operational mode: power, normal, or in an alarm state. s an alternative to the face-mounted integral LED, the control contractor shall provide relay-driven pilot lights mounted at the UC location, which shall provide the specified annunciation. UCs shall be configured for DIN rail mounting, using industry-standard clip-on adapters, or for direct panel mounting. Each controller shall be designed with on-board jacks for quick commissioning and troubleshooting with a portable programming tool.

E. Immunity to power and noise: Controllers shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

F. Transformer: Power supply for the ASC shall be rated at a minimum of 125 percent of ASC power consumption and shall be of the fused or current-limiting type.

2.10 HYDRONIC PC AIR UNIT POINTS LIST

	System Graphic	Digital Output	Digital Input	Analog Output	Analog Input	Alarm Point	Software Point
PC Air Unit	X						
Supply Fan Start-Stop and Status	X	X					
Supply Fan Status	X		X				
Supply Fan Runtime	X						X
Outdoor Air Temp	X				X		
Discharge Air Temp	X				X		
Cabin Temp	X				X		
Cooling Setpoint	X			X			
Heating Setpoint	X			X			
Heating Stage 1	X	X					
Heating Stage 2	X	X					
Cooling Coil Control Valve	X			X			

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	System Graphic	Digital Output	Digital Input	Analog Output	Analog Input	Alarm Point	Software Point
Damper Position or VFD	X			X			
On/Off/Auto Mode	X		X				
Duct Smoke Detectors (as required)	X		X				
Plenum Overtemp Alarm	X	X				X	
Blower Overload (on dampered units only)	X		X			X	
Coil Entering Temp	X				X		
Coil Leaving Temp	X				X		
Coil Flow	X				X		
Defrost Mode		X					
400 Hz ON/OFF Status		X					
400 Hz Fault		X					

PART 3 -

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which electric control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION (BRIDGE MOUNTED EQUIPMENT ONLY)

A. General:

1. Field check for clearances and interferences before fabrication.
2. Furnish all labor, tools, rigging equipment, scaffolding, and all other materials necessary to make a complete installation of the material and equipment specified and indicated.

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3. Prepare surfaces and spot apply primer and finishing paint on all equipment after installation where the shop paint has been damaged or flaked off.
4. 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.
5. Include all material, labor, and changes occasioned by the Contractor's choice of equipment.
6. All equipment furnished shall be installed complete including necessary piping, electrical connections, wiring, mounting, etc.
7. Contractor shall coordinate his work and interface of his work with others as required, including coordination with the bridge manufacturer to prevent damage to the bridge due to installation of Contractor furnished equipment.

B. Electrical Wiring and Installation:

1. Materials and equipment shall be in accordance with Division 26.
2. Install wiring in conduits and provide separate conduits for electronic control circuits. All control circuit wiring shall be 220 volts or less.

3.3 INSTALLATION OF ELECTRIC CONTROL SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions. Install electrical components and use electrical products complying with requirements of applicable Division 26 Sections of these Specifications. Mount controllers at convenient locations and heights.

B. Control Wiring: The term "control wiring" is defined to include providing of wire, conduit, and miscellaneous materials as required for mounting and connecting electric control devices.

C. Wiring System: Install complete control wiring system for electric control systems. Conceal wiring, except in mechanical rooms and AREAS where other conduit and piping are exposed. Provide multi conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

D. Number code or color code conductors appropriately for future identification and servicing of control system. Coding shall match designations shown on the manufacturer's control diagrams.

E. Unit Mounted Equipment: Where control devices are to be unit mounted, ship such devices to unit manufacturer for mounting and wiring at factory.

F. Furnish all the necessary components so that the system performs as specified.

G. Completely adjust and test the systems specified to ensure those control systems perform satisfactorily.

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H. Group control components together in a neat orderly fashion in control panels.

I. Permanently identify all control components by adhesive embossed plastic label corresponding to the numbers shown on the control diagrams submitted for approval.

J. Post control diagrams and operating sequences in a frame with glass or clear plastic lens adjacent to the main control station panel. The control diagrams and sequences in final form shall be submitted for approval.

K. Electronic sensing systems may use local control panel mounted electronic precision temperature indicators and resistance temperature detectors with panel mounted separate pushbuttons for each point of temperature indication in lieu of panel mounted dial thermometers.

3.4 STARTUP

A. Start up, test, and adjust electric control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Prepare test and inspection reports.

3.5 ADJUSTING AND CLEANING

A. Cleaning: Clean factory finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch up paint.

B. Final Adjustment: After completion of installation, adjust thermostats, control valves, motors and similar equipment provided as work of this Section.

1. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primacy temperature control system.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to assist Contractor and train Owner's maintenance personnel to adjust, operate, and maintain systems.

1. Provide services of manufacturer's technical representative for two (2) 8-hour days to instruct Owner's personnel in operation and maintenance of electrical control systems.
2. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

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PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 236616

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SECTION 236619 - PRECONDITIONED AIR SEQUENCE OF OPERATION - AVIATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for sequence of operation for preconditioned air. Sequence of operation is defined as the manner and method by which the control system (direct digital control) functions.

B. Related Sections:
   1. Section 236600 "Preconditioned Air Hydronic Air Handling Units - Aviation" for hydronic air handling units.
   2. Section 236616 "Preconditioned Air Electric Control Systems" for electric control systems.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 ACTION SUBMITTALS

A. Product Data: For preconditioned air sequence of operation.

   1. Submit sequence of operation description along with Piping and Instrumentation Diagram (P&ID) diagram indicating methods and equipment applied to achieve specified operation of PCA system.
   2. Include data substantiating that materials comply with requirements.

1.4 CLOSEOUT SUBMITTALS

A. Operation Data: For preconditioned air sequence of operation to include in emergency, operation, and maintenance manuals.

B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

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1.5 QUALITY ASSURANCE

A. Applicable Standards:

1. EIA 485: Standard for Electrical Characteristics of Generators and receivers for Use and Balanced Digital Multi Point Systems.

B. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of electric control equipment, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

1.6 PRECONDITIONED AIR SYSTEM SEQUENCE OF OPERATION

A. General: The preconditioned air system shall provide heated, cooled, or ventilated air to gates as indicated on the drawings. The control system shall be expandable to 50 gates per concourse for future build out.

B. The PCA system shall be designed such that the aircraft parked at the gates shall maintain an interior space temperature of 75 degrees F in the cooling season and 70 degrees F in the heating season (tolerance of +/ 2 degrees F). A minimum ventilation rate of 10 cfm/seat for the cooling mode and 5 cfm/seat for the heating mode shall be required. Cooling shall be provided for outdoor air temperatures of 45 degrees F and above during the dedicated cooling season. The central plant shall heat aircraft at an outdoor air temperature of 40 degrees F and below during the dedicated heating season.

C. The system shall be comprised of two (2) major components (on each concourse):

1. The air handling units and associated equipment located on each passenger bridge.
2. The direct digital control system.

1.7 SCHEDULE 2 - PRECONDITIONED AIR SYSTEM SEQUENCE OF OPERATION (DETAILED SEQUENCE)

A. PRODUCT DATA SHEET 1 - Start / Stop Control:

1. The system is started through a momentary "Start” push button. The system runs continuously unless stopped by the blower motor VFD, the smoke detector, the phase monitor, or pressing the “Stop” button.
2. Upon depressing the “Start” push buttons, the appropriate control relay energizes. A normally open contact on the control relay closes and signals the PCA controller (PCAC) that the unit has been started. The PCAC then energizes the VFD relay, which tells the VFD to start the blower motor. When the blower starts, the auxiliary contact on VFD opens and tells the PCAC that the blower is running. When the VFD relay is energized, the NO contact closes and power is provided to the rest of the control circuit. The PCAC will start the compressors or heaters as required.

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3. On system start-up, the VFD slowly starts the blower motor. This prevents power surges and hose snap.

B. PRODUCT DATA SHEET 2 - Fault Shut-Down:

1. The unit will initiate a "FAULT" (the red light on the “Stop” button) and shut the unit down for the following "out of normal" conditions.
2. The power monitor has tripped due to a phase reversal, voltage unbalance, low voltage, or loss of a phase.
3. The blower motor VFD overload has tripped.
4. The smoke detector has tripped.
5. Pushing the “Stop” button will reset the fault. Other components can stop operating without stopping the unit. Reasons include:
6. The condenser fans will shut down and fail to restart when the condenser fan motor overload trips.
7. Any of the compressors will shut down and not restart when the compressor motor overload trips. The compressors will shut down and restart automatically when the low suction pressure sensor trips or the high discharge pressure sensor trips.
8. The high-pressure switch is manual reset. Push the reset button on the pressure switch to reset.

C. PRODUCT DATA SHEET 3 - Control Software - Data Base

1. The PCA controller will automatically select the appropriate operational mode based on the ambient temperature.
2. The unit is controlled by the discharge temperature set point.
3. Several stages of cooling are provided. Modulation in cooling mode is obtained by cycling the compressors and controlled with hot gas by-pass.
4. If for any reason the discharge sensor becomes unreadable or unstable, the PCA controller will determine the sensor reading to be invalid and shutdown the unit. The unit will not restart until the sensor is repaired. The maintenance required light will turn on.
5. If the ambient sensor becomes unreadable or unstable, the PCA controller will determine the sensor reading to be invalid and it will default to 53 degrees F, (Vent mode) where the blower will run but no compressors or heaters will turn on.
6. If the aircraft cabin sensor becomes unreadable or unstable, the PCA controller will determine the sensor reading to be invalid and it will default to 90 degrees F in the cooling mode or 60 degrees F in the heating mode. The maintenance required light will turn on. This will allow the unit to operate normally but will be in the full cool or heat mode.

D. PRODUCT DATA SHEET 4 - Control Logic

1. The PCAC status changes to “On” when the start push button is energized. The program then provides a signal to the blower output point, the compressor output points, and the condenser fan output point.
2. There is a five-second delay between each component start-up to prevent high current in-rush.

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3. The discharge air temperature sensor reduces the capacity when the discharge air temperature drops below 32 degrees F (0 degrees C).
4. The condenser fans run whenever the unit is on. The second condenser fan will cycle on the high pressure. The fan will come on at 400 psig, and off at 300 psig.
5. The VFD starts the blower motor slowly to provide a soft start preventing hose snap and high-power inrush.
6. The compressors have a three-minute off delay to prevent rapid cycling of the compressors.

1.8 SCHEDULE 3 - PRECONDITIONED AIR SYSTEM CONTROL

A. PRODUCT DATA SHEET 1 - The PCA system shall be controlled by a BACnet Certified direct digital control system, which shall monitor and control the use of the PCA system and communicate directly with the EMCS. Upon failure of network communications, the PCA system shall be able to operate standalone with local controls. This system is built around the Automated Logic Controls (ALC) family of control components, including the OEMCtrl Product line.

B. PRODUCT DATA SHEET 2 - The PCA control system shall consist of the following four major functional elements:
1. The PC Air Chilled and heating plants at the Concourse (ACON and CCON), under ALC Controls
2. The PC Air Units (Under OEMCtrl)
3. The ALC Enterprise Server for PC Air System backup and programming.
4. The Energy Management Control System (EMCS), to provide monitoring and control of all PC Air System equipment.

C. PRODUCT DATA SHEET 3 - The major functional components of the EMCS are defined in other Division 23 Controls Sections.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace preconditioned air sequence of operation system that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Minimum two (2) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Automated Logic

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2. OEMCtrl

2.2 EQUIPMENT

A. Provide a fully programmable BACnet Certified microprocessor control system (direct digital control) inclusive of sensing and measuring devices for each concourse.

B. Software shall be user configurable with a complete library of energy management, measuring, control, reporting, alarming, and color graphic programs.

C. Each concourse shall operate independently; however, all concourses shall communicate directly with the EMCS.

2.3 HYDRONIC PC AIR UNIT POINTS LIST

	System Graphic	Digital Output	Digital Input	Analog Output	Analog Input	Alarm Point	Software Point
PC Air Unit	X						
Supply Fan Start-Stop and Status	X	X					
Supply Fan Status	X		X				
Supply Fan Runtime	X						X
Outdoor Air Temp	X				X		
Discharge Air Temp	X				X		
Cabin Temp	X				X		
Cooling Setpoint	X			X			
Heating Setpoint	X			X			
Heating Stage 1	X	X					
Heating Stage 2	X	X					
Cooling Coil Control Valve	X			X			
Damper Position or VFD	X			X			
On/Off/Auto Mode	X		X				
Duct Smoke Detectors (as required)	X		X				
Plenum Overtemp Alarm	X	X				X	

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	System Graphic	Digital Output	Digital Input	Analog Output	Analog Input	Alarm Point	Software Point
Blower Overload (on dampered units only)	X		X			X	
Coil Entering Temp	X				X		
Coil Leaving Temp	X				X		
Coil Flow	X				X		
Defrost Mode	X	X					

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which electric control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION GENERAL

A. Field check for clearances and interferences before fabrication.

B. Furnish all labor, tools, and all other materials necessary to make a complete installation of the material and equipment specified and indicated.

C. 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.

D. Include all material, labor, and changes occasioned by the Contractor's choice of equipment.

3.3 INSTALLATION OF SYSTEMS

A. General: Install systems and materials in accordance with manufacturer's instructions.

B. Furnish all the necessary components so that the system performs as specified.

C. Completely adjust and test the systems specified to ensure that they perform satisfactorily.

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3.4 STARTUP AND DEMONSTRATION

A. Start Up: Start up, test, and adjust systems in presence of Owner's Representative. Demonstrate compliance with requirements.

B. Engage a factory-authorized service representative to assist Contractor and train Owner's maintenance personnel to adjust, operate, and maintain systems.

1. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

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 236619

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SECTION 238219 - FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Ducted fan coil units and accessories.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
   2. Include data substantiating that materials comply with requirements.

B. Shop Drawings:

   1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members to which fan coil units will be attached.
   2. Method of attaching hangers to building structure.

B. Seismic Qualification Certificates: For fan coil units, accessories, and components, from manufacturer.

   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

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2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.6 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. Fan Coil Unit Filters: Furnish 2 sets spare filters for each filter installed.

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70. Listed and labeled by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other construction within the space.

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1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Fan failure.
b. Coil leak.

2. Warranty Period: Minimum four (4) years from date of Substantial Completion.

1.10 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

C. Radiated noise shall not exceed:
1. NC 45 – Maintenance Facilities.

2.2 DUCTED FAN COIL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. McQuay International; a member of Daikin Group.
3. Trane Inc.
4. or approved equal.

B. Fan Coil Unit Configurations: Row split.
1. Number of Cooling Coils: One with two-pipe system.

C. Coil Section Insulation: 1/2-inch- (13-mm-) thick, [**foil-faced**] glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

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1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Coil Section Insulation: Insulate coil section according to Section 230616 "HVAC Equipment Insulation."

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.

F. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel. Floor-mounting units shall have leveling screws.

G. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.

1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis with mill-finish, aluminum, double-deflection grille.
2. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with transfer- and return-air, formed-steel balancing dampers.
3. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

H. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.

I. MERV Rating: 8 when tested according to ASHRAE 52.2.
1. Pleated Cotton-Polyester Media: 90 percent arrestance and MERV8.

J. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain.

K. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

1. Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

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L. Factory, Hydronic Piping Package: ASTM B 88, Type L (ASTM B 88M, Type B) copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

1. Two-way, [**modulating**] control valve for chilled-water coil.
2. [Hose Kits: Minimum 400-psig (2758-kPa) working pressure and operating temperatures from 33 to 211 deg F (0.5 to 99 deg C). Tag hose kits to equipment designations.

    a. Length: 24 inches (600 mm).
    b. Minimum Diameter: Equal to fan coil unit connection size.

3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.
4. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig (860-kPa) working pressure, 250 deg F (121 deg C) maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.
5. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig (860-kPa) working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 (DN 15) hose-end, full-port, ball-type blowdown valve in drain connection.
6. Wrought-Copper Unions: ASME B16.22.
7. Provide dielectric unions for connection to steel piping.

M. Remote condensing units are specified in Section 236200 "Packaged Compressor and Condenser Units."

N. Control devices and operational sequence are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

O. Basic Unit Controls:

1. Control voltage transformer.
2. Wall-mounting thermostat with the following features.

    a. Cool-off switch.
    b. Exposed set point.
    c. Exposed indication.
    d. Degree F indication.

P. DDC Terminal Controller:

1. Scheduled Operation: Fan shall operate continuously.

2. Hydronic-Cooling-Coil Operation:

    a. Occupied Periods: Modulate control valve to maintain room temperature.

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3. Transfer-Air Damper Operation:

   a. Balance transfer air damper as indicated on plans and lock damper in position. Return air damper to balance as indicated on plans and locked into position.

Q. Interface with DDC System for HVAC Requirements:

1.
2. Interface relay to provide indication of fault at the central workstation.
3. Interface shall be BACnet/MSTP and include the following functions:

   a. Adjust set points.
   b. Fan coil unit operating status.
   c. Valve monitoring and control
   d. Fully point access, including but not limited to hydronic coil (s) supply and return temperatures, supply and return air temperatures, and room-air temperature.

R. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Coordinate to assure correct recess size for recessed units.

C. Install fan coil units level and plumb.

D. Install fan coil units to comply with NFPA 90A.

E. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage to other materials.

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F. Protection: Provide finished cabinet units with protective covers during balance of construction.

G. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

H. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above finished floor.

I. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.
4. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
5. Install piping adjacent to machine to allow service and maintenance.

    a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. 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.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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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 :

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

D. Remove and replace malfunctioning units and retest as specified above.

E. Retest as specified above after repairs or replacements are made.

F. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose.

3.6 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filters.

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

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described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 238219

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SECTION 260400 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Certain labor, materials, and equipment may be furnished under other Sections of these specifications, by utility Companies or by the Owner. When this is the case, the extent, source and description of these items will be as indicated on the drawings or as described in the specifications.

B. Where a panel is installed, at least 25% of panel capacity, accounting for serving panel capacity, shall remain as spare capacity after project completion.

C. 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.

F. Related Sections:

1. Basic Electrical Requirements specifically applicable to all Division 26 Sections, in addition to Division 1 General Requirements, and Divisions 11, 21, 22, 23, 27 and 28.
2. All electrical/electronic circuits and equipment from any other Division shall meet the requirements of Division 26.
3. Description: Work shall consist of furnishing all labor, equipment, supplies, and materials, unless otherwise specified, necessary for the installation of complete electrical systems as required by the specifications and as shown on the drawings, subject to the terms and conditions of the Contract. The Work shall also include the completion of those details of electrical work not mentioned or shown which are necessary for the successful operation of all electrical systems.

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4. Temporary Power: See Division 1 for construction power constraints.

G. REFERENCE STANDARDS

H. 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.

I. Latest editions of the following:

1. ANSI/NFPA 70 - National Electrical Code (as adopted and amended by the Denver Building Department).
2. International Fire Code (as amended by the Denver Fire Department).
3. International Building Code (as adopted and amended by the Denver Building Department).
4. International Energy Conservation Code (as adopted and amended by the Denver Building Department).
5. ANSI/IEEE C2 - National Electrical Safety Code.
6. OSHA - Occupational Safety and Health Administration, as Amended
7. Underwriter’s Laboratory (UL).
8. National Fire Protection Association (NFPA).
9. Other references as listed elsewhere in these specifications.
10. IEEE Standard 519- Recommended Practices and Requirement for Harmonic Control in Electrical Power Systems.

1.3 DEFINITIONS

A. "Furnish" or "Provide": To supply, install and connect complete and ready for safe and regular operation of particular work unless specifically otherwise noted.

B. "Install": To erect, mount and connect complete with related accessories.

C. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

D. "Work": Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

E. "Wiring": Raceway, fittings, wire, boxes and related items.

F. "Concealed": Embedded in masonry, concrete or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.

G. “?Or Equal. Or Approved Equal”: Refers to products that, in the opinion of the DEN Project Manager, are similar in all respect to products specified by proprietary brand name. (Refer to Section 01630 for procedures for submittal of proposed substitutions.)

H. "Exposed": Not installed underground or "concealed" as defined above.

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I. "Indicated," "Shown" or "Noted": As indicated, shown or noted on drawings or specifications.

J. "Similar" or "Equal": Same in materials, weight, size, design, construction, capacity, performance, and efficiency of specified product.

K. "Reviewed," "Satisfactory," "Accepted," or "Directed": As reviewed, satisfactory, accepted, or directed by or to DEN Project Manager.

L. "Related Work" includes all "Work" required for a complete working system.

M. "Equipment": A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as a part of, or in connection with, an electrical installation.

N. "Busbar": A rigid metallic conductor, lug or bar used to make a common connection between more than one circuit. (Includes all termination assemblies.)

O. "Shall": Mandatory requirements of this specification are characterized by the use of the word "shall".

P. Refer to Article 100 of the currently adopted National Electrical Code for other definitions as applicable to this Project.

1.4 WORK SEQUENCE

A. Construct Work in sequence under provisions of Division 1 where applicable.

1.5 DRAWINGS AND SPECIFICATIONS

A. The Drawings indicate the general arrangement of circuits, outlets, panelboards and other work. Information shown on the Drawings is schematic; however, re-circuiting will not be permitted without specific acceptance. In cases of conflict between specifications and drawings, the specification shall have precedence. Data presented on the drawings is as accurate as planning can determine, but accuracy is not guaranteed and field verification of all dimensions, locations, levels, etc., to suit field conditions is required. Review all of the Contract Documents and adjust all work to conform to all conditions shown therein.

B. Prior to submitting a bid, a site visit is required to ascertain all conditions affecting the proposed installation and to adjust all work accordingly. Costs for providing for these adjustments, including response to site constraints, shall be itemized and listed in the bid proposal.

C. Discrepancies between different plans, between plans and specifications, between specifications, or regulations and codes governing this installation shall be brought to the attention of the DEN Project Manager in writing 72 hours before the date of bid opening. In the event such discrepancies exist, and the DEN Project Manager is not so notified, the adjudication of responsibility shall be solely at the discretion of the

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DEN Project Manager.

1.6 COORDINATION

A. Prior to fabrication or installation of any electrical work, participate in detailed coordination planning meetings with all other building utilities system trades, under the direction of the General Contractor, so as to completely establish routings, elevations, space requirements, and coordination of access, layout, and suspension requirements in relationship to the building structure and the work of all other trades.

B. Any electrical work penetrating concrete walls or floors shall require saw cutting and/or core drilling and shall require approval by the DEN Project Manager. The Contractor shall perform all necessary imaging (x-rays, etc.) as specified, and submit shop drawings of any saw cutting or core drilling to the DEN Project Manager prior to performing the Work. Refer to Section 017330 "Cutting and Patching" for additional requirements.

C. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.

1.7 COORDINATION DRAWINGS

A. Where the Contractor modifies the design, through selection of equipment differing from that shown, coordination drawings shall be provided by the Contractor in accordance with Division 1 to a scale of 1/4"=1'0" or larger for equipment rooms, details, congested areas and sections; other plans at a scale of 1/8"=1'0". These drawings are to detail major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components.

B. Coordination drawings shall be in accordance with current DEN standards for format, and as outlined in Division 1.

C. The Contractor shall indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of raceway systems, equipment, and materials. Include the following:

    a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
    b. Exterior wall and foundation penetrations.
    c. Fire-rated wall and floor penetrations.
    d. Equipment connections and support details.
    e. Sizes and location of required concrete pads and bases.

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f. Support details.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Floor plans, elevations, and appropriate details are required to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

1.8 SUBMITTALS

A. Refer to Section 013300 "Submittal Procedures".

B. Submit shop drawings, coordination drawings and product data in accordance with provisions of Division 1. Submit all required information under a given specification section together. Do not split out submittals under the same specification section.

C. Prior to submission, shop drawings, material lists and catalog cut sheets or manufacturer's printed data shall be thoroughly checked for compliance with Contract requirements, compatibility with equipment being furnished by the Contractor or Owner, accuracy of dimensions, coordination with work of other trades, and conformance with sound and safe practice as to erection of installation. Each submittal shall bear Contractor's signed statement evidencing such checking.

D. Clearly mark each shop drawing as follows for purposes of identification:

1. Shop Drawing.
2. Equipment Identification Used on Contract Drawings.
3. Date.
4. Name of Project.
5. Branch of Work.
6. Project Manager's Name.
7. Contractor's Name.

E. Clearly mark printed material, catalog cut sheets, pamphlets or specification sheets, and shop drawings with the same designation shown on the Contract document schedules. Contractor agrees that submittals processed by the DEN Project Manager are not change orders; that the purpose of submittals is to demonstrate to the DEN Project Manager that the Contractor understands the design concept; and that the Contractor demonstrates this understanding by indicating which equipment and material the Contractor intends to furnish and install and by detailing the installation methods the Contractor intends to use.

F. Contractor shall be responsible for dimensions (which the Contractor shall confirm and correlate at the job site), fabrication processes and techniques of construction, and coordination of the Contractor's Work with that of other trades. The Contractor shall check and verify all measurements and review shop drawings before submitting them. If any deviations from the specified requirements for any item of material or equipment exist, such deviation shall be expressly stated in writing and incorporated with the submittal.

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G. Maintain one copy of accepted shop drawings at the Project field office until completion of the Project, and make this copy available, upon request, to representatives of the DEN Project Manager and Owner.

H. No equipment or materials shall be installed or stored at the jobsite until submittals for such equipment or materials have been given review action by the DEN Project Manager accepting their use.

I. Shop drawings and manufacturer's published data shall be submitted for all equipment required for this Project.

1.9 RECORD DOCUMENTS

A. Maintain a Contract set of electrical drawings and specifications at the site. Neatly mark all changes, discoveries and deviations from the original drawings. Use a reproducible color that contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be updated daily as the job progresses and shall be made available for inspection by the DEN Project Manager at all times. Upon completion of the Contract, this set of record drawings shall be delivered to the DEN Project Manager. Follow current DEN BIM standards, to be furnished to the successful bidder as well as the project-specific BIM execution plan. Record documents to be provided by the Contractor shall clearly and accurately show the following:

1. Provide horizontal and vertical dimensions for all raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.10 REGULATORY REQUIREMENTS

A. Obtain all permits, plan review, and inspections from authority having jurisdiction.

B. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent than the drawings and specifications.

1.11 ENVIRONMENTAL CONDITIONS

A. The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:

1. Location: Indoors/Outdoors.

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2. Altitude: 5,500 feet above sea level.
3. Temperature range: -30ºF to 120ºF.

1.12 WARRANTY

A. The entire electrical system installed under this Contract shall be left in proper working order. Replace, at no additional cost to the Owner, any work, materials, or equipment which evidences defects in design, construction, or workmanship within two (2) years, or any longer period specifically noted elsewhere in these specifications, from date of substantial completion.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and Equipment: Acceptable to the authority having jurisdiction as suitable for the use intended, except where more stringent requirements are indicated by the Contract Documents.

B. All equipment and materials installed shall be new, unless otherwise specified.

C. Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the DEN Project Manager or Owner and at no additional cost to the Owner.

D. All electrical "equipment" and assemblies shall be acceptable for installation only if labeled and listed by a nationally recognized testing laboratory, such as UL or an equivalent.

E. All major equipment components shall have the manufacturer's name, address, model number, and serial number permanently attached in a conspicuous location.

2.2 STORAGE AND PROTECTION

A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

B. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering and provide ventilation to avoid condensation.

C. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged and are maintained under required conditions.

2.3 PRODUCT OPTIONS

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A. Products Specified by Reference Standards or by Description Only:

1. Any product meeting those standards.

B. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions:

1. Submit a request for substitution for any manufacturer not specifically named with supporting documentation for approval by DEN Project Manager.

2.4 PRODUCTS LIST

A. Within fifteen (15) days after date of Notice to Proceed, submit complete list of major products required for submittal under these specifications, with name of manufacturer, trade name, and model number of each product.

2.5 SUBSTITUTIONS

A. Refer to Division 1 General Requirements, Section 012510 "Substitutions".

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Only quality workmanship will be accepted. Poor workmanship, improper layout of work and lack of coordination of Work, as determined by the DEN Project Manager, are not acceptable and shall be corrected at the contractors cost.

B. Contractor shall include no more than one apprentice per Journeyman Electrician. Apprentices shall be under the direct supervision of a licensed electrician at all times.

C. Any changes or deviations from the drawings and specifications must be accepted in writing by the DEN Project Manager. All errors in installation shall be corrected at the expense of the Contractor. All specialties shall be installed as detailed on the drawings. Where details or specific installation requirements are not provided, manufacturer's recommendations shall be followed.

D. Upon completion of Work, all equipment and materials shall be installed complete, thoroughly tested, checked, correctly adjusted, and left ready for intended use or operation. All Work shall be thoroughly cleaned and all residues shall be removed from surfaces. Exterior surfaces of all material and equipment shall be left in a perfect, unblemished condition.

E. Contractor shall provide a complete installation, including all required labor, material, cartage, testing, insurance, permits, and taxes.

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3.2 CHASES, OPENINGS, CUTTING AND PATCHING

A. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the Owner and to the satisfaction of the DEN Project Manager. Any necessary cutting, channeling, drilling or welding as required for the proper support, concealment, installation or anchoring of raceways, outlets, or other electrical equipment shall be performed in a careful manner, and shall be pre-approved by the DEN Project Manager.

B. All 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. Reference specification Section 078413 "Penetration Firestopping" for additional information.

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.

3.3 ELECTRICAL INSTALLATIONS

A. Coordinate electrical systems, equipment, and material installation with other building components. If the Contractor furnishes equipment of a different size, the Contractor shall furnish and install the proper fuses, circuit breaker, disconnect switch, wire and conduit required for the equipment furnished, at no additional cost to the Owner, and as deemed acceptable by the DEN Project Manager.

3.4 PROGRESS OF WORK

A. Coordinate the progress of electrical work to conform to the progress of the Work of the other trades. Complete the entire installation as soon as the condition of the sites will permit. Any cost resulting from defective or ill-timed work performed under Division 26 shall be borne by the Contractor.

3.5 ELECTRICAL COMPLETION

A. 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 cleanup of the site will be charged against the Contractor.

B. Acceptance Demonstration: Upon completion of the Work, at a time to be designated

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by the DEN Project Manager, the Contractor shall demonstrate for the Owner the operation of the entire installation, including all systems provided or modified under this Contract.

C. Final Acceptance by the Owner will not occur until all operating instructions are received and Owner's personnel have been thoroughly indoctrinated in the maintenance and operation of all equipment, as approved by DEN Project Manager.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 METHOD OF PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION **260400**

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SECTION 260505 - SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 RELATED SECTIONS

A. Section 011000 "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.

B. Section 024119 "Selective Demolition" for demolition and removal of selected site elements.

C. Section 260400 "Basic Electrical Requirements."

D. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements.

1.3 ALTERNATES

A. Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

PART 2 - PRODUCTS

2.1 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

3.1 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.

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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

4.1 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 **260505**

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SECTION 260510 - TESTING, ACCEPTANCES AND CERTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY OF REQUIREMENTS

A. The Contractor shall provide the necessary field-testing and startup services for all electrical and mechanical equipment except as noted otherwise. The field-testing and startup services shall be in accordance with each equipment manufacturer's written recommendations for field-testing proving they meet Contract standards.

B. The Contractor shall be responsible for furnishing all equipment, power source when needed, coordinating and performing electrical/electronic testing required by the Contract Documents. Testing requirements may be located on the Contract Drawings or other sections of the specifications.

C. The Contractor shall provide all necessary assistance and cooperation with any Independent Testing Organization furnishing by the City. The Contractor shall correct, repair, or replace all equipment found to be defective by the Independent Testing Organization.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Without limiting the generality of other requirements of these Specifications, all Work specified herein shall conform to or exceed the applicable requirements of the referenced Standards; provided, that wherever the provisions of said publications are in conflict with the requirements specified herein, the more stringent requirements shall apply unless in conflict with the equipment manufacturer's written recommendations:

1. Building Code and DEN Standards.
2. ANSI/IEEE C2 - National Electrical Safety Code.
3. OSHA - Occupational Safety and Health Administration, as Amended
4. NETA - National Electric Testing Association
5. NEMA ICS 1 - General Standards for Industrial Control and Systems.
6. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies.
7. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
8. UL 1008 - Standard for Automatic Transfer Switches.
9. NFPA 70 - National Electrical Code, including but not limited to use in emergency and standby systems in accordance with Articles 517, 700, 701 and 702.

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10. NFPA 72 - National Fire Alarm Code (as adopted and amended by the Denver Building Code and DEN Standards).
11. NFPA 101 - National Electrical Safety Code (as adopted and amended by the Denver Building Code and DEN Standards).
12. NFPA 110 - Standard for Emergency and Standby Power Systems (as adopted and amended by the Denver Building Code and DEN Standards).
13. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems (Orange Book)
14. NEMA Standard ICS-2-447 - AC Automatic Transfer Switches.
15. IEC - Standard for Automatic Transfer Switches.

1.4 SUBMITTALS

A. Comply with Division 1 submittal requirements.

B. Five (5) copies of complete certified test reports shall be submitted to the DEN Project Manager by the contractor. Electronic copy of test reports in pdf format to also be submitted to the DEN Project Manager. The test reports shall include the following as a minimum:

1. Power cable high potential test reports:

    a. Insulation resistance tests.
    b. Continuity tests.

2. Transformer test reports to include where applicable:

    a. Transformer turns ratio.
    b. Winding resistance.
    c. Insulation power factor.
    d. K Factor.

3. All electrical/electronic equipment and systems functional test report.
4. All other reports required by individual specification sections.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The electrical and mechanical equipment shall be completely tested in the field in the presence of DEN Inspectors in accordance with good and accepted industry engineering practices to assure that:

1. The equipment has not been damaged during manufacturing, shipping, or installation.
2. The equipment has been installed according to the requirements Contract Documents.
3. The equipment meets the requirements of the Contract Documents.

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B. If the Contractor finds during the testing that any piece of equipment failed to satisfactorily pass the required field test, the DEN Project Manager shall be promptly notified and the Contractor shall take the necessary actions for the prompt repair 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.

2.2 HVAC

A. Test the operation of all heaters and air conditioners.

B. Test the Lead Lag Control circuits.

2.3 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

2.4 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:	**Resistance:**
(AWG or KCMIL)	(Megaohms - 1,000 ft.)
12-8	200
6-2/0	100
3/0-750	100

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. TESTING

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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

4.1 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 260510

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
   1. 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.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

   1. Include data substantiating that materials comply with requirements.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

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1.7 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.

1.8 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 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 **THHN-THWN**.

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

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conductor, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

2.2 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

3.1 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.

3.2 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. Branch Circuits Concealed in Ceilings, Walls, and Partitions: [**Type THHN-THWN, single conductors in raceway**].

D. 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.

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E. 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.

F. All power, control, data, communication and signal wire or cable shall be installed in an approved raceway.

3.3 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.

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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.

3.4 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.

3.5 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.

3.6 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 Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to

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restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.8 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. 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.

3. 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

4.1 METHOD OF MEASUREMENT

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

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PART 5 - PAYMENT

5.1 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 260519

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Grounding systems and equipment.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 SYSTEM DESCRIPTION

A. .

B. External (underground) metal pipes, water, gas, fuel, drain/sewer etc., are not available for electrical grounding. This is due to extensive cathodic protection and isolation joints of all underground metal pipes at DEN. These systems shall be bonded to the grounding system on the building side only.

C. Ground each separately derived system neutral to nearest building steel or referenced ground plate in the electrical room.

D. Provide a minimum of three inch by twelve inch by one-quarter inch (3” x 12” x ¼”) copper ground bar in the electrical room for connecting the grounding systems.

E. An insulated equipment ground conductor shall be installed continuous from the main switchgear or service entrance to all branch panelboards, motor control centers, transformers and all motors. This conductor shall be bonded to the conduit and metal enclosures that it passes through utilizing bonding bushings and terminal devices.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1. Include data substantiating that materials comply with requirements.

1.5 INFORMATIONAL SUBMITTALS

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A. Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:
   1. Grounding arrangements and connections for separately derived systems.
   2. Grounding for sensitive electronic equipment.

B. Qualification Data: For qualified testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

   1. Instructions for periodic testing and inspection of grounding features at **grounding connections for separately derived systems** based on [**NETA MTS**] [**NFPA 70B**].
   2. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
   3. Include recommended testing intervals.

B. Record Documents

   1. Maintain a contract set of electrical drawings and specifications at the site. Neatly mark all changes, discoveries, and deviations from the original drawings. Use a reproducible color that contrasts with the prints. This shall be a separate set of drawings, not used for construction purposes, and shall be updated daily as the job progresses and shall be made available for inspection by the DEN Project Manager at all times. Upon completion of the contract, this set of record drawings shall be delivered to the DEN Project Manager. Follow DEN BIM standards, to be furnished to the successful bidder. Record documents to be provided by the Contractor shall clearly and accurately show the following:

      a. Provide horizontal and vertical dimensions for all raceway systems, size, and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
      b. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
      c. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and

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application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

1.8 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Codes.

B. All ground wires shall be copper, sized according to the NEC or as shown on the drawings whichever is larger.

C. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

D. Grounding Bus: Predrilled rectangular bars of annealed copper, **1/4 by 4 inches (6.3 by 100 mm)** in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

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1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions. Exothermic welded connections are required where grounding conductors connect to underground grounding conductors and to underground grounding electrodes, and for bonding to steel. All underground connections shall be exothermic welded.

D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

E. Grounding Connection Accessories:

1. Electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type of service required.

2.3 GROUNDING ELECTRODES (Not Applicable)

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. **12** AWG and smaller, and stranded conductors for No. **10** AWG and larger unless otherwise indicated.

B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 2 inches (50 mm) minimum from wall, 6 inches (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of doorframe, across top of doorway, and down to specified height above floor; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

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3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

G. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring

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closet, and central equipment location.

2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch (6.3-by-100-by-300-mm) grounding bus.
3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Retain and revise first paragraph below to exceed NFPA 70 requirements, and comply with NFPA 70 recommendations for a higher standard of safety or electromagnetic interference suppression if needed.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install [**tinned**]bonding jumper to bond across flexible duct connections to achieve continuity.

3.4 LABELING

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" Article for instruction signs.

B. Install labels at the telecommunications bonding conductor and grounding equalizer **and at the grounding electrode conductor where exposed**.

1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

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3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
4. Perform tests by fall-of-potential method according to IEEE 81.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: **10** ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: **5** ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: **3** ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: **3** ohm(s).

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify DEN Electrical Engineer promptly and include recommendations to reduce ground resistance.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

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5.1 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.

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. 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.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force.

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1.5 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.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.8 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.9 COORDINATION (Not Applicable)

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.

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PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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. 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. 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.

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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, **zinc-coated** steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.
        6) or approved equal.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.
7. Pneumatic-Actuated Fasteners: For use in ceilings only and by approval of DEN Project Manager. Powder-actuated tools are prohibited. Threaded-steel stud, for use in pan deck cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
        5) or approved equal.

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2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as **required by** NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. 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, single-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel**.

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.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the

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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" 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" conduits, three (3) 3/4" conduits or two (2) 1" conduits shall be supported on a single 1/4" 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.

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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.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS (Not Applicable)

3.4 CONCRETE BASES

A. Install all freestanding electrical equipment on a 4" concrete housekeeping pad.

B. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

C. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section[**s**] "[**033000 Cast-in-Place Concrete**] [**033053 Miscellaneous Cast-in-Place Concrete**]."

D. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

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.

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PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 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 260529

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SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Surface raceways.
3. Boxes, enclosures, and cabinets.

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.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. RMC: Rigid Metallic Conduit.

C. RNC: Rigid Nonmetallic Conduit.

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D. EMT: Electrical Metallic Conduit.

E. FMC: Flexible Metallic Conduit.

F. LFMC: Liquidtight Flexible Metallic Conduit.

G. HDPE: High Density Polyethelene.

H. FNC: Flexible Nonmetallic Conduit.

I. ENT: Electrical non-metallic conduit.

J. MC: Metal-clad cable.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Samples: Per request.

1.5 INFORMATIONAL SUBMITTALS (Not Applicable)

1.6 CLOSEOUT SUBMITTALS (Not Applicable)

1.7 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 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.

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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 (1 mm), with overlapping sleeves protecting threaded joints.

2.2 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

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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.

2.3 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

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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. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).

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.

H. Small Sheet Metal Pull and Junction Boxes: Galvanized steel. NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, **galvanized, cast iron** with gasketed cover.

J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

K. 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.

L. Gangable boxes are allowed.

M. 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.

N. 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

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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.

PART 3 - EXECUTION

3.1 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. 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. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Wet Locations: GRC.
7. 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.

C. 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.

D. Minimum Raceway Size: 1/2-inch (16-mm) trade size.

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E. 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.

F. Install surface raceways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

H. 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.

3.2 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”) 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 (610 mm) of changes in direction.

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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 (610 mm) 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. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture during construction.

K. Exposed conduits subject to physical damage to be rigid steel to 6'-0" above floor, deck or grating except in electrical, communications and mechanical rooms.

L. 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.

M. Flexible steel conduit runs shall not exceed 6’ 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.

N. 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.

O. 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.

P. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

Q. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

R. 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 (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

S. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

T. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove

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coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

U. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

V. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 160-lb (72-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

W. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) 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.

X. 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.

Y. 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.

Z. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

AA. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC **and EMT** conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch

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per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) 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 (0.0115 mm per meter of length of straight run per deg C) 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..

BB. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for **recessed and semirecessed 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.

CC. Size conduit for conductor type installed or for Type THHN conductors, whichever is larger.

DD. Arrange conduit to maintain headroom and present a neat appearance. Certain existing conditions may allow a waiver to this item.

EE. 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.

FF. 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.

GG. Do not support conduit from cable tray or cable tray supports.

HH. 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.

II. 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.

JJ. X-ray studies shall be made of concrete floors, walls or CMU walls prior to drilling or cutting of concrete and submitted to the DEN Project Manager for review and approval.

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KK. 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.

LL. Coordinate installation of outlet or equipment boxes for systems or products furnished under other sections.

MM. 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.

NN. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Provide minimum 8 inch separation.

OO. Locate boxes so that cover or plate will not span different building finishes.

PP. 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.

QQ. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

RR. Set metal floor boxes level and flush with finished floor surface.

SS. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

TT. 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.

UU. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed light fixture.

VV. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.

WW. Use adjustable steel channel fasteners or all thread for hanging ceiling outlet box, support box from structure.

XX. Support boxes in the ceiling with ¼" threaded rod as a minimum.

YY. Use appropriate gang box where more than one device is mounted together.

ZZ. Use 4 inch square box with plaster ring for single device outlets.

AAA. Use malleable iron outlet box when surface mounted: on exterior of building, in wet location or damp location.

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BBB. Minimum junction and pull box size 4-11/16" x 4-11/16" x 2-1/8" .

CCC. Minimum outlet box size 4" x 4" x 2-1/8” including feed through outlet boxes.

DDD. 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.

EEE. Use flush mounting outlet boxes in finished areas.

FFF. Install knockout closure in unused box openings.

GGG. Install cabinets and enclosures plumb; anchor securely to wall and structural supports at each corner, minimum.

HHH. All floor-mounted equipment shall be on a 4" nominal concrete housekeeping pad.

III. No cabinet shall be supported on slab or grade.

3.3 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.4 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

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

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END OF SECTION 260533

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SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

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. 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.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include data substantiating that materials comply with requirements.

1.4 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.

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PART 2 - PRODUCTS

2.1 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 (0.6-mm) 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 (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 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.

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g. or approved equal.

2. Sealing Elements: **EPDM** or 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.

2.3 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.

2.4 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 (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 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.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

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PART 3 - EXECUTION

3.1 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. Comply with requirements in Division 07 Section "Joint Sealants."
    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 (6.4-mm) 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 (50 mm) 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.

3.2 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.

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3.3 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

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 260544

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SECTION 260548 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Spring isolators.
3. Restrained spring isolators.
4. Channel support systems.
5. Restraint cables.
6. Hanger rod stiffeners.
7. Anchorage bushings and washers.

B. Related Sections include the following:

1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 DEFINITIONS

A. The IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: **B**.

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2. Assigned Seismic Use Group or Building Category as Defined in the IBC: **I**.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by **an agency acceptable to authorities having jurisdiction**.
    b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
4. Include data substantiating that materials comply with requirements.

B. Delegated-Design Submittal: For **vibration isolation and** seismic-restraint details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.

    a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other Division 26 Sections for equipment mounted outdoors.

2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
3. Field-fabricated supports.
4. Seismic-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events.[**Indicate association with vibration isolation devices.**]
    c. Preapproval and Evaluation Documentation: By **an agency acceptable to authorities having jurisdiction**, showing maximum ratings of restraint

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items and the basis for approval (tests or calculations).

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.

B. Qualification Data: For professional engineer.

C. Welding certificates.

D. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.8 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

D. Comply with NFPA 70.

1.9 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

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PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.
10. or approved equal.

B. Pads : Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant **neoprene**.

C. Spring Isolators : Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- (6-mm) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

D. Restrained Spring Isolators : Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm) thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

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4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti Inc.
5. Loos & Co.; Seismic Earthquake Division.
6. Mason Industries.
7. TOLCO Incorporated; a brand of NIBCO INC.
8. Unistrut; Tyco International, Ltd.
9. or approved equal.

B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by **an agency acceptable to authorities having jurisdiction**.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least **four** times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: [**ASTM A 603 galvanized**] [**ASTM A 492 stainless**]-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: [**Steel tube or steel slotted-support-system sleeve with internally bolted connections**] [**Reinforcing steel angle clampe**d] to hanger rod. Do not weld stiffeners to rods.

F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.

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H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive **vibration isolation and** seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by **an agency acceptable to authorities having jurisdiction**.

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B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment and Hanger Restraints:

1. Install restrained isolators on electrical equipment.
2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by **an agency acceptable to authorities having jurisdiction** providing required submittals for component.

B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Anchoring deeper than 1-1/2” 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.
3. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
4. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
5. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
6. Set anchors to manufacturer's recommended torque, using a torque wrench.
7. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

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8. Plastic or fiber anchors are prohibited.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through DEN Project Manager, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven (7) days' advance notice.
3. Obtain DEN Project Manager's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least **four (4)** of each type and size of installed anchors and fasteners selected by DEN Project Manager.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of

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operation.

3.7 ELECTRICAL VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Supported or Suspended Equipment: .

1. Equipment Location: .
2. Pads:

   a. Material: **Neoprene**.
   b. Thickness: 2 inches (mm).
   c. Durometer: 70.
   d. Number of Pads: <**Insert number**> thick.

3. Isolator Type: Neoprene.
4. Component Importance Factor: **1.5**.
5. Component Response Modification Factor: **1.5**.
6. Component Amplification Factor: **1.0**.

PART 4 - METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION **260548**

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1. Include data substantiating that materials comply with requirements.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1**and IEEE C2**.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

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D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

1.6 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch (75-mm) high letters on 20-inch (500-mm) centers.

C. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch (100-mm-) wide black stripes on 10-inch (250-mm) centers diagonally over orange background that extends full length of raceway or duct and is 12 inches (300 mm) wide. Stop stripes at legends.

D. Pre-Printed Tags: Polyester tag, **0.010 inch (0.25 mm)** or **0.015 inch (0.38 mm)** thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

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1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Pre-Printed Tags: Polyester tag, [**0.010 inch** (0.25 mm)] [**0.015 inch** (0.38 mm)] thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

F. Pre-Printed Tags: Polyester tag, [**0.010 inch** (0.25 mm)] [**0.015 inch** (0.38 mm)] thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

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2.4 FLOOR MARKING TAPE

A. 2-inch (50-mm) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.5 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted 20 gauge steel signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 14 by 10 inches (360 mm by 250 mm) unless 7 by 10 inches (180 by 250 mm) is the largest size that can be applied where needed.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.

E. Nominal size, 14 by 10 inches (360 mm by 250 mm) unless 7 by 10 inches (180 by 250 mm) is the largest size that can be applied where needed.

F. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

G. Plasticized Tags:

1. Manufacturer's standard preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matte finish suitable for writing, approximately 3-1/4-inch x 5-5/8-inch, with brass grommets and wire fasteners, and with appropriate preprinted wording including large-size primary wording, including but not limited to the following legends: "DANGER", "CAUTION"," DO NOT OPERATE".

2.6 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

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1. Engraved legend with [**black letters on white face**].
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm).

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.7 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black letters on white background, by thermal transfer or equivalent process. Minimum letter height shall be 1/4 inch (7 mm).

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black letters on white background, by thermal transfer or equivalent process. Minimum letter height shall be 1/4 inch (7 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic, or Melamine Label: Adhesive backed, with black letters on white background. Minimum letter height shall be 1/4 inch (7 mm).

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 1/4 inch (7 mm).

E. Stenciled Legend: In nonfading, waterproof, **black** ink or paint. Minimum letter height shall be **1 inch (25 mm)**.

F. Emergency Equipment labels shall be white letters on red background..

G. Provide nameplates with a minimum letter height as indicated below. Examples are given below for the size of letters to use for a given application and this not a list of the equipment to be identified. All equipment is required to be identified.
1. Individual circuit breaker and spaces in panel boards: for numbers (section number) 1/4 inch.
2. Individual switches and pilots: 1/8 inch, identify mechanical unit being served.
3. Disconnects, relay panels, lighting contactors: 1/4 inch for voltage and source circuit number.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 1/8 inch (3 mm).

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2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of

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two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

G. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Wire and Cable Marker:

1. For wire/cables smaller than No. 2/0 use manufacturer's standard cable/conductor markers of wrap-around, pre-numbered plastic coated type are to be used and numbered to show circuit identification.
2. For cables No. 4 AWG and larger heat shrink sleeving is to be used for phase color-coding.

B. Cable/Conductor Identification:

1. The application of cable/conductor identification, with circuit number, on each wire / cable in each box/enclosure/cabinet is required. The identification shall match the marking system used in panel boards, shop drawings, and contract documents.

    a. Provide labels on all wires, including in boxes where wires are pulled through but not terminated, such as junction boxes.

C. System Color Coding Schedule:

1. Electrical emergency power conduits, including all feeders and branch circuits serving or connected to emergency systems as defined in NEC 700.2, shall have “RED” stripes on each section every 5 feet of electrical conduit (visible from the floor or above a suspended ceiling) and within 3 feet of all equipment. All associated junction or pull boxes shall have the cover painted red.
2. ECS conduits installed to serve systems specified in shall have “GREEN” bands, 5’ on centers for the entire length of conduit run. All junction or pull boxes shall have the cover painted green with the associated zone number written neatly on the box cover with permanent marker.
3. Temperature control conduits shall have “BROWN” bands, 5’ on centers for the entire length. All junction or pull boxes shall have the cover painted brown.
4. Fire Alarm conduit shall be a continuous red factory finish.

D. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than A, and V to ground: Identify with self-adhesive vinyl label self-adhesive vinyl tape applied in bands. Install labels at maximum intervals.

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E. Junction and Pull Box ID: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Emergency Work: EM.
2. Power.
3. Uninterruptible Power Supply: UPS.
4. Fiber Optics: FO.
5. Closed Circuit Television: CCTV.
6. Paging System: PA.
7. Radio Frequency: RF.
8. Fire Alarm: FA.
9. Temperature Control: TC.

F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase Identification, 600 V or Less: Use colors listed below for branch-circuit conductors.

   a. Color shall be factory applied **or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit**.
   b. Colors for 208/120-V Circuits:

      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
      4) Neutral: White
      5) Ground: Green
      6) Isolated Ground: Green with a yellow tracer

   c. Colors for 480/277-V Circuits:

      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
      4) Neutral: Gray
      5) Ground: Green
      6) Isolated Ground: Green with a yellow tracer

   d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

G. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit

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designation.

H. Install instructional sign including the color-code for conductors using adhesive-film-type labels.

I. Conductors to Be Extended in the Future: Attach write-on tags marker tape to conductors and list source.

J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions and terminals. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

K. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels Baked-enamel warning signs Metal-backed, butyrate warning signs.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:

    a. Power transfer switches.
    b. Controls with external control power connections.

M. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Mechanically fastened, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch (13-mm) high letters on 1-1/2-inch (38-mm) high label; where two lines of text are required, use labels 2 inches (50 mm) high. Use black lettering on white field for normal and white letters on a red field for

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emergency. Provide text matching terminology and numbering of the contract documents and shop drawings. The sign shall include unit designation, source circuit number, circuit voltage, and other data specifically indicated. Also, the sign shall indicate normal source circuit number ("Fed from . . .") and emergency source circuit number when the equipment is a transfer switch or fed directly from a transfer switch.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine label Stenciled legend 4 inches (100 mm) high.
c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: include main bus ampacity on sign.Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be [**self-adhesive, engraved**] [**engraved**], laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Switchboards.
d. Disconnect switch.
e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
f. Substations.
g. Emergency system boxes and enclosures.
h. Enclosed switches.
i. Selector switches, indicating lights. (Circuit number and voltage not required on sign).
j. Enclosed circuit breakers.
k. Enclosed controllers.
l. Variable-speed controllers.
m. Push-button stations.
n. Contactors.
o. Remote-controlled switches, dimmer modules, and control devices.
p. Fire alarm panels.
q. Security monitoring master station.
r. Relays
s. Lighting contactors
t. Individual distribution circuit breakers

3. All panel boards shall have a typed panel schedule indicating the date, contractor, type of equipment served, and its location.

3.3 EQUIPMENT NAMING

A. Electrical Panels shall be named according to the panel names indicated on the drawings.

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B. Naming Disconnects and Transformers

1. Disconnects shall have the same as the equipment they serve.
2. Transformers shall have the same name as the low-voltage panel they supply power to with the extension of -X

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 260553

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SECTION 260573 – ARC FLASH AND OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

C. This section also includes requirements for providing an arc flash hazard analysis and labeling all electrical equipment including switchgear, switchboards, panel boards, transformers, safety switches and other equipment likely to be examined, tested or worked on while energized.

1.3 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

1. Include data substantiating that materials comply with requirements.

B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals [**shall**] be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For coordination-study and arc flash study specialist.

B. Product Certificates:

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1. For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
2. For Arc Flash software program, certifying compliance with IEEE 1584.

1.5 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study and Arc Flash study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc.
6. ETAP Inc.
7. or approved equal.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming

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time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

    a. Arcing faults.
    b. Simultaneous faults.
    c. Explicit negative sequence.
    d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other electrical Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Busway ampacity and impedance.
    g. Motor horsepower and code letter designation according to NEMA MG 1.

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4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

    1. Switchgear and switchboard bus.
    2. Distribution panelboard.
    3. Branch circuit panelboard.
    4.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with [**IEEE 141**] [**IEEE 241**] and IEEE 242.

    1. Transformers:

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a. ANSI C57.12.10.
b. ANSI C57.12.22.
c. ANSI C57.12.40.
d. IEEE C57.12.00.
e. IEEE C57.96.

2. Medium-Voltage Circuit Breakers: IEEE C37.010.
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.

B. Comply with [**IEEE 141**] recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

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2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

3.5 Arc Flash Study and labelling requirements

A. Perform arc study using approved computer software program. Prepare labels that will be affixed to all new electrical equipment being supplied with the project. Comply with IEEE 1584.

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1. Display nominal system voltage
2. Display incident Energy
3. Display PPE level
4. Display working distance
5. Display Arc Flash hazard boundary
6. Display the equipment name, including the power source it is fed from

B. Labels to be placed in a location that is clearly visible to qualified persons before they begin work.

C. Arc Flash labels must be able to withstand their usage environment

PART 4 - METHOD OF MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION **260573**

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SECTION 260583 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Electrical connections to equipment specified under other Sections or furnished by the Owner.

B. Applications of electrical power, control and monitoring connections specified in this section include the following:

1. 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**] [**Division 23**] [**Division 27**] [**Division 28**] sections for motor starters and controllers furnished integrally with equipment; not criteria of this Section.
9. Refer to **Division 22**, **Division 23** and**Division 28** 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.

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1.3 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.

1.4 CLOSEOUT SUBMITTALS

A. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.5 QUALITY ASSURANCE

A. Products, materials, equipment and systems shall comply with the following Codes and Standards:

1. NFPA Compliance: NFPA 70, “National Electrical Code (NEC)” as adopted and amended by the Denver Building Code and as applicable to products used and the installation of electrical power connections (terminals and splices), junction boxes, motor starters and disconnect switches.
2. IEEE Compliance: Std. 241, “IEEE Recommended Practice for Electric Power Systems in Commercial Buildings” pertaining to connections and terminations.
3. ANSI Compliance: Applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.
4. UL Compliance: UL Std. 486A, “Wire Connectors and Soldering Lugs for Use with Copper Conductors” including, but not limited to, tightening of electrical connectors to torque values indicated. Electrical connection products and materials are to be UL-listed and labeled.

1.6 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

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PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. Products shall be as specified in other Sections of this Division.

B. General: Each electrical connection shall be a complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, stress cones, splice kits, termination kits, solder less wire nuts, and other items and accessories as needed to complete splices and terminations as required.

1. Connectors and Terminals: Electrical connectors and terminals shall mate and match, including sizes and ratings, with equipment terminals that are recommended by equipment manufacturer for intended applications.
2. Electrical Connection Accessories: Electrical insulating tape, heat-shrinkable insulating tubing and boots, stress cones, splice kits, termination kits, wirenuts and cable ties as recommended for use by accessories manufacturers for type of services required.

2.2 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

3.1 INSPECTION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 PREPARATION

A. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

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3.3 INSTALLATION

A. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.

B. Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit in damp or wet locations. Length shall be six feet (6') maximum.

C. Install pre-finished cord set where connection with attachment plug is indicated or specified, use attachment plug with suitable strain-relief clamps.

D. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes.

E. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring as required for a complete operating system.

F. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as required for a complete operating system. Connect with conduit and wiring as required for a complete operating system.

3.4 EQUIPMENT CONNECTION SCHEDULE

A. 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

3.5 INSTALLATION OF ELECTRICAL CONNECTIONS

A. Electrical connections shall be installed in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with

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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.

3.6 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

4.1 MEASUREMENT

A. No separate measurement will be made for the work specified in this Section.

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PART 5 - PAYMENT

5.1 PAYMENT

A. No separate payment will be made for work specified in this Section, but shall be included in the Contract Lump Sum Bid Price for Division 16 - Electrical, which price shall include all necessary and incidental material and work thereto.

END OF SECTION 260583

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SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

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 Section, apply to this Section.

B. Related Specification Sections:

1. Section 017515 – “System Startup, Testing and Training,” for startup, testing and training procedures.
2. Section 017900 – “Demonstration and Training,” for demonstration and training content and requirements.
3. Section 019113 - “General Commissioning Requirements,” for general commissioning procedures, definitions and requirements.

1.2 SUMMARY

A. Section Includes:

1. General commissioning requirements for electrical systems.

B. Equipment-specific commissioning requirements are contained in each Section for the related equipment.

1.3 DEFINITIONS

A. 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.

B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

C. 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.

D. Pre-Start Up: Preliminary testing accomplished during a scheduled system outage to verify system functionality prior to placing the system/equipment into preliminary service.

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E. 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.

1.4 RESPONSIBILITY

A. Refer to Section 019113 “General Commissioning Requirements” for general responsibilities of the CxA and the Contractor.

B. Division 26 (electrical) contractor’s commissioning responsibilities shall include:

1. All inspection and manipulation of live electrical equipment as required to perform commissioning activities.
2. Coordination of electrical shutdowns as required to perform commissioning activities. All electrical shutdowns must be submitted in writing to the DEN Project Manager not less than (5) days prior to the scheduled shutdown.

C. CxA’s responsibilities electrical commissioning responsibilities shall include:

1. Collect and organize results of all pre-startup, startup, and functional performance testing performed by CxA and Contractor, including all testing set forth in Division 26. Test results shall be included in the commissioning report.
2. Document issues in the Issues Log.

1.5 SYSTEMS TO BE COMMISSIONED

A. Electrical Systems:

1. Automatic transfer switches.
2. Emergency power distribution.
3. Ground fault [**protection**] [**and**] [**detection**].
4. Lighting controls.
5. Protective device selective coordination.
6. Surge protection devices.
7. UPS systems.

B. Life Safety Systems:

1. Emergency communications system.
2. Fire alarm system.

1.6 COORDINATION

A. Electrical commissioning activities shall comply with all applicable safety standards, rules and regulations, including but not limited to:

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1. DEN Airport Safety Policy.
2. ROCIP safety requirements.
3. Contractor's approved site-specific safety plan.
4. NFPA 70E, current edition.

B. Refer to Section 011400 "Work Sequence and Constraints" for general work sequencing and coordination requirements.

C. CxA and Contractor shall coordinate all commissioning-related activities as directed by the DEN Project Manager.

1.7 ACTION SUBMITTALS

A. Comply with the requirements of Section 013300 "Submittal Procedures."

B. CxA submittals:

1. Include information pertaining to Division 26 equipment for all commissioning submittals required in accordance with Section 019113 "General Commissioning Requirements."
2. Electrical commissioning activity matrix:

    a. CxA shall review the Division 26 specifications and ensure that all required equipment commissioning activities are addressed in the commissioning plan.
    b. Commissioning plan shall include an activity matrix, showing all required commissioning activities associated with Division 26, including CxA and Contractor activities, including but not limited to submittal reviews, installation observation, pre-startup, startup, functional testing, acceptance testing, training, deferred testing, and warranty walkthrough. CxA shall ensure the commissioning activity matrix is inclusive of all testing described in the Contractor's electrical testing plan. Matrix shall include:

        1) Activity name.
        2) Description.
        3) Responsibility matrix (showing responsible, accountable, consulted, and informed parties for each activity).
        4) Anticipated start date.
        5) Anticipated end date.

C. Contractor submittals:

1. Comply with the requirements of Section 019113 "General Commissioning Requirements" for all Division 26 equipment to be commissioned.
2. Contractor's electrical testing plan, including:

    a. Equipment to be tested.
    b. Operating modes to be tested, for each equipment type.
    c. Dates of testing.

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d. Responsible parties.

3. Test procedures: Submit for each equipment type. Procedures shall be formatted for use in equipment testing and shall include:

   a. Responsible subcontractor.
   b. A list of integral components being inspected or tested.
   c. Test equipment used.
   d. Associated checklists, if any.
   e. Special required conditions, if any.
   f. Items, conditions or functions to be inspected, verified, or tested, and the testing method to be used.
   g. Acceptance criteria.
   h. Sampling strategy, if any.
   i. Space for recording of equipment information.
   j. Space for recording all test results after each prescribed test.

4. Test Results: Submit for each piece of tagged equipment. Results shall utilize the accepted test procedures form and shall include:

   a. Tagged equipment name/number. If equipment is untagged, include location and any additional information as needed to positively identify the equipment.
   b. Manufacturer and model number.
   c. Performance information and rating data.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 SUBMITTALS

A. CxA shall submit electrical commissioning activity matrix not less than (30) days prior to start of first planned activity.

B. Not less than (60) days before any onsite testing activities are conducted, Contractor shall submit an overall electrical testing plan and schedule for electrical systems as described in Part 1. Testing activities shall be included in the construction schedule.

C. CxA shall review Contractor’s electrical testing plan and revise commissioning activity matrix to include all activities as described in Contractor’s testing plan.

D. Contractor shall submit test procedures for each type of equipment not less than (14) days prior to start of testing of that equipment type.

E. Contractor shall submit test results not more than (14) days following completion of associated testing, or as directed by the DEN Project Manager.

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3.2 TESTING

A. Contractor shall perform pre-testing of all equipment to verify proper operation.

B. Refer to Section 019113 “General Commissioning Requirements” for test sampling and procedures related to nonconforming work.

C. Test procedures for dynamic equipment:

1. Dynamic electrical equipment is equipment which includes multiple operating modes, responses and/or sequences, and shall include but is not limited to the following:

a. Scheduled, occupancy-based or daylight-responsive lighting controls.
b. UPS systems.
c. Fire Alarm systems.

2. Test procedures for dynamic equipment shall be written as step-by-step testing instructions, including expected responses and sample results.

D. Test procedures for static equipment:

1. Static equipment includes electrical equipment designed for static operation and shall include but is not limited to the following:

a. Panel boards.
b. Switchgear.
c. Transformers.
d. Circuit breakers and safety switches.

2. Test procedures for static equipment may be written in a checklist format, as appropriate for the equipment.

E. Refer to individual Sections contained in Division 26 for equipment-specific testing requirements.

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

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described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 260800

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SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Indoor occupancy sensors. (In-fixture Control)
   2. Emergency shunt relays.

B. Related Requirements:

   1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

C. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include data substantiating that materials comply with requirements.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

   1. Interconnection diagrams showing field-installed wiring.
   2. Include diagrams for power, signal, and control wiring.

C. Coordination Drawings: Include drawings to show lighting control equipment layouts and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

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C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

B. Torque Values: Submit torque values for all connections with a torque schedule and witness signature.

C. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA 29 CFR 1910.7, or a member company of the International Electrical Testing Association that is acceptable to authorities having jurisdiction.

B. Source Limitations: Obtain lighting control equipment components through one source from a single manufacturer.

C. Firms responding to this specification shall provide proof that they have been regularly engaged in the design, manufacturing and testing of lighting control equipment for not less than five (5) years.

1.7 WARRANTY

A. Manufacturer shall provide a product warranty for a period of not less than two (2) years from date of installation. Warranty shall cover unlimited replacement of lighting control equipment modules during the warranty period.

1.8 SEQUENCING AND SCHEDULING

A. The lighting control equipment installation is to be sequenced and scheduled with other work to reduce possibility of damage to equipment during the remainder of construction period.

B. Power Outages: Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.

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1.9 EXTRA MATERIALS

A. Furnish extra materials including ten (10) percent of installed units, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver materials as directed by DEN Project Manager.

1.10 ENVIRONMENTAL CONDITIONS

A. The lighting control equipment unit shall be capable of continuous operation under the following temperature conditions:

1. Relative humidity: 95% non-condensing.
2. Altitude: 5500 feet (1667 meters) without any de-rating.
3. Functioning: -30°F (-34°C) (Outdoor) to 120°F (49°C) (Indoor & Outdoor).
4. The neutral shall not be combined for lighting circuits with electronic or dimming ballasts, and should be bonded according to local codes and National Electrical Code (NEC).

1.11 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Leviton Manufacturing Co., Inc.
3. Lithonia Lighting; Acuity Brands Lighting, Inc.
4. or approved equal.

2.2 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Industries, Inc.
2. Leviton Manufacturing Co., Inc.
3. Lithonia Lighting; Acuity Brands Lighting, Inc. [In-fixture Control]
4. Watt Stopper.

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B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

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4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
2. Leviton Manufacturing Co., Inc.
3. Lithonia Lighting; Acuity Brands Lighting, Inc.
4. Watt Stopper.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of [900 sq. ft. (84 sq. m)] [2100 sq. ft (196 sq. m)].
2. Sensing Technology: [**PIR**] [**Dual technology - PIR and ultrasonic**].
3. Switch Type: [**SP.**] [**SP, dual circuit.**] [**SP, manual "on," automatic "off."**] [**SP, field selectable automatic "on," or manual "on" automatic "off."**]

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4. Voltage: [**Match the circuit voltage**] [**120 V**] [**277 V**] [**Dual voltage, 120 and 277 V**]; [**passive-infrared**] [**dual-technology**] type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

D. Wall-Switch Sensor Tag WS2:

1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: PIR.
3. Switch Type: [**SP.**] [**SP, dual circuit.**] [**SP, manual "on," automatic "off."**] [**SP, field selectable automatic "on," or manual "on" automatic "off."**]
4. Voltage: [**Match the circuit voltage**] [**120 V**] [**277 V**] [**Dual voltage, 120 and 277 V**]; [**passive-infrared**] [**dual-technology**] type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.4 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lighting Control and Design.
2. Watt Stopper.
3. Lithonia Lighting; Acuity Brands Lighting, Inc.
4. or approved equal.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual [**or automatic**]switching contacts; complying with UL 924.

1. Coil Rating: [**120**] [**277**] V.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [**No. 18**] [**No. 22**] [**No. 24**] AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than[**No. 14**] [**No. 16**] [**No. 18**] AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. Tighten lighting control equipment assembly joints with torque wrench or similar tool recommended by bus assembly manufacturer. Tighten joints again after lighting systems have been energized for 30 days.

F. Connect lighting control equipment assemblies and components to wiring system and to ground as indicated and instructed by manufacturer.

G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

H. Torque Values: Submit torque values for all connections with a torque schedule and witness signature.

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3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Manufacturer's representative shall visit site, verify installation, start up and test, and submit to DEN Project Manager, a letter stating equipment and installation meets intent of Contract Documents and manufacturer's warranties and guarantees are in effect

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within [**twelve (12)**] <**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to [**two (2)**] <**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

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3.6 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris. Repair damaged finish to match original finish.

3.7 PROTECTION

A. Provide final protection to ensure that moisture does not enter lighting control equipment assembly.

3.8 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.13 "Addressable-Fixture Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."

B. Engage a factory-authorized service representative to assist Contractor and train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

1. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

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 260923

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SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to [**SEI/ASCE 7**] .

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[**and the unit will be fully operational after the seismic event**]."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required

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clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified [**testing agency**].

B. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

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1.7 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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two (2) of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two (2) of each size and type.
3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three (3) of each size and type.
4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three (3) of each size and type.
5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three (3) of each size and type.
6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one (1) of each size and type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and [**install temporary electric heating (250 W per section)**] to prevent condensation.

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C. Handle and prepare switchboards for installation according to [**NECA 400**] .

1.10 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Location: Indoors/outdoors.
    b. Ambient Temperature: Not exceeding 120 deg F (49 deg C).
    c. Altitude: 5500 feet (1677 m), not exceeding 6600 feet (2000 m).

C. Unusual Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without DEN Project Manager's written permission.
4. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

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Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Minimum [**two (2)**] years from date of Substantial Completion.

1.13 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. or approved equal.

B. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: [**Panel**] mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

C. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

D. Indoor Enclosures: Steel, NEMA 250, [**Type 1**] .

E. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's [**standard gray**] finish over a rust-inhibiting primer on treated metal surface.

F. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

G. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

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H. Pull Box on Top of Switchboard:

1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
2. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
3. Bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
4. Cable supports shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.

I. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, [**silver-plated,**]with tin-plated copper feeder circuit-breaker line connections.
2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with [**mechanical**] connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
3. Ground Bus: [**1/4-by-2-inch-** (6-by-50-mm-)] [**1/4-by-1-inch-** (6-by-25-mm-)] [**Minimum-size required by UL 891,**] hard-drawn copper of 98 percent conductivity, equipped with [**mechanical**] connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
5. Neutral Buses: 50 percent of the ampacity of phase buses unless otherwise indicated, equipped with [**mechanical**] connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
6. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with [**mechanical**] connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.

J. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

K. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

L. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components including instruments and instrument transformers.

2.2 TRANSIENT VOLTAGE SUPPRESSION DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. or approved equal.

B. Surge Protection Device Description: IEEE C62.41-compliant, integrally mounted, [**wired-in**] [**plug-in**] or [**bolt-on**], solid-state, parallel-connected, [**modular (with field-replaceable modules)**] type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the switchboard short-circuit rating, and with the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Redundant suppression circuits.
5. Redundant replaceable modules.
6. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
7. LED indicator lights for power and protection status.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
10. [**Four**] -digit, transient-event counter set to totalize transient surges.

C. Peak Single-Impulse Surge Current Rating: [**160 kA per mode/320 kA per phase**] .

D. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.

E. Protection modes and UL 1449 SVR for grounded wye circuits with [**480Y/277**] [**208Y/120**] -V, three-phase, four-wire circuits shall be as follows:

1. Line to Neutral: [**800 V for 480Y/277**] [**400 V for 208Y/120**].
2. Line to Ground: [**800 V for 480Y/277**] [**400 V for 208Y/120**].
3. Neutral to Ground: [**800 V for 480Y/277**] [**400 V for 208Y/120**].

F. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:

1. Line to Neutral: 400 V, 800 V from high leg.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

G. Protection modes and UL 1449 SVR for 240-, or 480-, three-phase, three-wire, delta circuits shall be as follows:

1. Line to Line: [**2000 V for 480 V**] [**1000 V for 240 V**].

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2. Line to Ground: [**1500 V for 480 V**] [**800 V for 240 V**].

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with [**interrupting capacity**] to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: [**Mechanical**] style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: [**Integrally mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    f. Communication Capability: [**Integral**] communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
    g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at [**55**] [**75**] percent of rated voltage.
    h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage

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without intentional time delay.

i. Auxiliary Contacts: [**One SPDT switch**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

B. Insulated-Case Circuit Breaker (ICCB): [**80**] [**100**] percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.

1. [**Fixed**] circuit-breaker mounting.
2. Two-step, stored-energy closing.
3. [**Full**]-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time time adjustments.
    c. Ground-fault pickup level, time delay, and I2t response.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
5. Remote trip indication and control.
6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
8. Control Voltage: [**120-V ac**].

9. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Boltswitch, Inc.
    b. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
    c. Pringle Electrical Manufacturing Company, Inc.
    d. Siemens Energy & Automation, Inc.
    e. Square D; a brand of Schneider Electric.
    f. or approved equal.

10. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.
11. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.

    a. Electrical Trip: Operation of lever or push-button trip switch, or trip signal from ground-fault relay or remote-control device, causes switch to open.
    b. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

12. Auxiliary Switches: Factory installed, single pole, double throw, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.

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13. Service-Rated Switches: Labeled for use as service equipment.
14. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

    a. Configuration: [**Integrally mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
    c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
    d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

15. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.
16. Ground-Fault Relay: Comply with UL 1053; self-powered type with mechanical ground-fault indicator, test function, tripping relay with internal memory, and three-phase current transformer/sensor.

    a. Configuration: [**Integrally mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    b. Internal Memory: Integrates the cumulative value of intermittent arcing ground-fault currents and uses the effect to initiate tripping.
    c. No-Trip Relay Test: Permits ground-fault simulation test without tripping switch.
    d. Test Control: Simulates ground fault to test relay and switch (or relay only if "no-trip" mode is selected).

17. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

D. Fuses are specified in Section 262813 "Fuses."

2.4 INSTRUMENTATION

A. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:

1. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, [**single**] [**tapped**] [**double**] secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; [**wound**] [**bushing**] [**bar or window**] type; [**single**] [**double**] secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
3. Control-Power Transformers: Dry type, mounted in separate compartments for

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units larger than 3 kVA.

4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

   a. Phase Currents, Each Phase: Plus or minus 1 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
   d. Megawatts: Plus or minus 2 percent.
   e. Megavars: Plus or minus 2 percent.
   f. Power Factor: Plus or minus 2 percent.
   g. Frequency: Plus or minus 0.5 percent.
   h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
   i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
   j. Contact devices to operate remote impulse-totalizing demand meter.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

C. Impulse-Totalizing Demand Meter:

1. Comply with ANSI C12.1.
2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
3. Cyclometer.
4. Four-dial, totalizing kilowatt-hour register.
5. Positive chart drive mechanism.
6. Capillary pen holding a minimum of one month's ink supply.
7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
8. Capable of indicating and recording [**15**] -minute integrated demand of totalized system.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

B. Control Circuits: 120-V ac, supplied from remote branch circuit.

C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload

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protection of transformer and fuses for protection of control circuits.

D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

C. Portable Circuit-Breaker Lifting Device: Floor-supported, roller-based, elevating carriage arranged for movement of circuit breakers in and out of compartments for present and future circuit breakers.

D. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

E. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

2.7 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to [**NECA 400**] .

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

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A. Install switchboards and accessories according to [**NECA 400**] .

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in [**Section 033000 "Cast-in-Place Concrete."**] [**Section 033053 "Miscellaneous Cast-in-Place Concrete."**]

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, surge protection devices, and instrumentation.

1. Set field-adjustable switches and circuit-breaker trip ranges.

H. Install spare-fuse cabinet.

I. Comply with NECA 1.

3.3 CONNECTIONS

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

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C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Switchboard will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges [**as specified in Section 260573 "Overcurrent Protective Device Coordination Study."**]

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to assist Contractor and train

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Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories[**, and to use and reprogram microprocessor-based trip, monitoring, and communication units**].

1. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

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 262413

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to **SEI/ASCE 7**.

1. The term "withstand" means, "The unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **and the unit will be fully operational after the seismic** even]."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For each panelboard and related equipment.

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1. Detail enclosure types and details for types other than NEMA 250, Type 1.
2. Detail bus configuration, current, and voltage ratings.
3. Short-circuit current rating of panelboards and overcurrent protective devices.
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include wiring diagrams for power, signal, and control wiring.
7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Panelboard Schedules: For installation in panelboards.[**Submit final versions after load balancing.**]

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: [**Two (2)**] spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: [**Two (2)**] spares for each panelboard.

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3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to [**NECA 407**] [**NEMA PB 1**].

1.11 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding minus 30 deg F (minus 35 deg C) to

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plus 120 deg F (plus 49 deg C).

b. Altitude: 5500 feet (1677 m), not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude: 5500 feet, not exceeding 6600 feet (2000 m).

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.
2. Do not proceed with interruption of electric service without DEN Project Manager's written permission.
3. Comply with NFPA 70E.

1.12 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.13 WARRANTY

A. Special Warranty: for Surge Suppression Devices Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Minimum [**five (5)**] years from date of Substantial Completion.

1.14 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

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PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: [**Flush- and surface**]-mounted cabinets.

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: NEMA 250, [**Type 1**].
    b. Outdoor Locations: NEMA 250, [**Type 3R**].
    c. Other Wet or Damp Indoor Locations: NEMA 250, [**Type 4**].

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
6. Finishes:

    a. Panels and Trim: [**Steel**] [**and**] [**galvanized steel**], factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: [**Galvanized steel**].

7. Enclosures shall be at least 20 inches wide made from galvanized sheet steel in the sizes and NEMA types indicated, code gauge, minimum 16 gauge thickness
8. Directory Card: Inside panelboard door, mounted in [**metal frame with transparent protective cover**].
9. Remote electrical metering equipment as detailed on design documents.

C. In all cases where the conductor to be connected to the busbar is 1/0 or larger cable, the connection shall be made with a 2-hole compression lug. Torque all lug, wire and bus terminations to the manufacturers recommendation using a micrometer type wrench.

D. Incoming Mains Location: [**Top**].

E. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors;

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insulated from box.

4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads, with a corresponding increase in the size of the grounded conductor back to the supply.
5. Split Bus: Vertical buses divided into individual vertical sections.

F. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: **Mechanical** type.
3. Ground Lugs and Bus-Configured Terminators: **Mechanical** type.
4. Feed-Through Lugs: **Mechanical** type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: **Mechanical** type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: **Mechanical** type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

G. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

H. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

J. Breakers shall have built-in test points for testing long delay, and instantaneous functions of the breaker by means of a 120 volt operated test kit.

K. General Requirements for Branch Circuit Panelboards:

1. Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers, of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
2. Circuit breakers shall be thermal magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame and up through 100-ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be UL listed as Type SWD for lighting circuits.

    a. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management and control system (EMCS) panels and fire alarm panels.
    b. Main circuit breaker, when shown, shall be vertical mounted top or bottom as required. Chassis mounted reverse fed main circuit breaker is not acceptable.

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3. Circuit breakers shall have a minimum interrupting rating of 10,000 amperes symmetrical at 240 volts and 14,000 amperes symmetrical at 480 volts.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Match existing manufacturer in the immediate area, if applicable. Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.
4. or approved equal.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: [**Circuit breaker**].

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: [**Bolt-on**] circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

G. Branch Overcurrent Protective Devices: Fused switches.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.
4. or approved equal.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: [**Circuit breaker**] [**or**] [**lugs only**].

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

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F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Square D; a brand of Schneider Electric.
4. or approved equal.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with fully-rated **interrupting capacity** to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 600 A and below.
2. Breakers with frame sizes above 600 amperes shall be solid state trip, complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have trip rating plugs with ratings as indicated on the drawings. Rating plugs shall be interlocked so they are NOT interchangeable between frames and interlocked such that a breaker cannot be latched with the rating plug removed.
3. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: **Mechanical** style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: [**Integrally mounted**] relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Communication Capability: [**Circuit-breaker-mounted**] [**Universal-mounted**] communication module with functions and features

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compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."

f. Shunt Trip: [**120**] -V trip coil energized from separate circuit, set to trip at [**75**] percent of rated voltage.
g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage [**with field-adjustable 0.1- to 0.6-second**] time delay.
h. Auxiliary Contacts: [**Two SPDT switches**] with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
k. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Division 26 Section "Fuses."
2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
3. Auxiliary Contacts: [**One**] normally open and normally closed contact(s) that operate with switch handle operation.

2.5 PANELBOARD SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology; a subsidiary of Danahar Corporation.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
4. Liebert Corporation.
5. Square D; a brand of Schneider Electric.
6. or approved equal.

B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

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1. Accessories:

    a. LED indicator lights for power and protection status.
    b. Audible alarm, with silencing switch, to indicate when protection has failed.
    c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.

C. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, [**plug-in**] [**wired-in**] [**bolt-on**], solid-state, parallel-connected, [**modular (with field-replaceable modules)**] type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:

    a. Fuses rated at 200-kA interrupting capacity.
    b. Fabrication using bolted compression lugs for internal wiring.
    c. Integral disconnect switch.
    d. Redundant suppression circuits.
    e. Redundant replaceable modules.
    f. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
    g. LED indicator lights for power and protection status.
    h. Audible alarm, with silencing switch, to indicate when protection has failed.
    i. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
    j. [**Four**] -digit, transient-event counter set to totalize transient surges.

2. Peak Single-Impulse Surge Current Rating: [**160 kA per mode/320 kA per phase**].
3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.

    a. Line to Neutral: [**70,000**] A.
    b. Line to Ground: [**70,000**] A.
    c. Neutral to Ground: [**50,000**] A.

4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
5. Protection modes and UL 1449 SVR for grounded wye circuits with [**480Y/277**] [**208Y/120**] [**600Y/347**]-V, three-phase, four-wire circuits shall be as follows:

    a. Line to Neutral: [**800 V for 480Y/277**] [**400 V for 208Y/120**] [**1200 V for 600Y/347**].
    b. Line to Ground: [**800 V for 480Y/277**] [**400 V for 208Y/120**] [**1200 V for 600Y/347**].
    c. Neutral to Ground: [**800 V for 480Y/277**] [**400 V for 208Y/120**] [**1200 V for**

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600Y/347].

6. Protection modes and UL 1449 SVR for 240/120-V, single-phase, three-wire circuits shall be as follows:

   a. Line to Neutral: 400 V.
   b. Line to Ground: 400 V.
   c. Neutral to Ground: 400 V.

7. Protection modes and UL 1449 SVR for 240/120-V, three-phase, four-wire circuits with high leg shall be as follows:

   a. Line to Neutral: 400 V, 800 V from high leg.
   b. Line to Ground: 400 V.
   c. Neutral to Ground: 400 V.

8. Protection modes and UL 1449 SVR for 240-, 480-, or 600-V, three-phase, three-wire, delta circuits shall be as follows:

   a. Line to Line: [**2000 V for 480 V**] [**1000 V for 240 V**] [**2500 V for 600 V**].
   b. Line to Ground: [**1500 V for 480 V**] [**800 V for 240 V**] [**2500 V for 600 V**].

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to [**NECA 407**] [**NEMA PB 1.1**].

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

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A. Install panelboards and accessories according to [**NECA 407**] [**NEMA PB 1.1**].

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim [**78 inches (1982 mm)**] above finished floor unless matching height of existing equipment or approved otherwise.

F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

G. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub five 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub five 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties[**after completing load balancing**].

K. Comply with NECA 1.

3.3 PANELBOARD SCHEDULE

A. Panelboards shall be furnished and equipped as follows, except as otherwise specified:

Manufacturer:	120/208V:	277/480V:	600- 1200A:
Cutler Hammer	PRL-1	PRL-2	PRL-3 or 4
Square-D	NQOD	NEHB	I-LINE

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GE NLAB NHB CCB
Or approved equal by other manufacturer.

B. Panelboards may contain not more than one subfeed breaker with ratings in excess of 100A, but less than 225A.

C. Distribution panelboard shall be scheduled where more than one subfeed breaker rated in excess of 100A is required, and for any panelboard containing breakers with ratings of 225A or more.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads[**after balancing panelboard loads**]; incorporate Owner's final room designations. Clearly identify the load on each circuit, equipment serviced and location. Revise directory to reflect circuiting changes required to balance phase loads. In all instances where a contractor installs or disconnects a circuit in any panel, a newly typed panel schedule shall be furnished. The new or revised panel schedule shall have the date and Contractor’s name typed at the top right hand corner. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

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1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections, preparing a written report for each including test results:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard eleven (11) months after date of Substantial Completion.
    c. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Submit torque values for all connections with a torque schedule and witness signature.

3.6 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges [**as indicated**]

C. Load Balancing: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this

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minimum requirement.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION **262416**

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SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

B. Related Specifications:

1. Section 230923 “Direct Digital Control (DDC) System for HVAC.”
2. Section 260523 “Control-Voltage Electrical Power Conductors and Cables.”
3. Section 260533 “Raceways and Boxes for Electrical Systems.”
4. Section 260553 “Identification for Electrical Systems.”

1.2 SUMMARY

A. Section includes:

1. Equipment for [**electricity metering by Owner or Tenant**].
2. Service Entrance requirements.
3. Secondary Connection Cabinet requirements.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 DEFINITIONS

A. BACNet: Communications protocol for Building Automation and Control (BAC) network based on ASHRAE, ANSI, and ISO 16484-5 standard protocol.

B. BACNet MS/TP: RS-485 based communication layer defined in the BACNet protocol, based on master-slave/token-passing network topology.

C. EMCS: Energy Management Control System. DEN centralized, networked supervision and control system for HVAC control and energy management.

D. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

E. PC: Personal computer.

1.4 ACTION SUBMITTALS

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A. Product Data: For each type of product indicated.

1. Include data substantiating that materials comply with requirements.
2. For BACNet-connected devices, submit BACNet Protocol Implementation Conformance (PIC) Statement with product data.

B. Shop Drawings: For [**Owner**] electricity-metering equipment.

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

    a. Include floor plans depicting EMCS system connections, associated existing devices, and conduit pathways.

3. Graphics Modifications: For EMCS. Include all new or modified graphics pages, submitted in PDF format. All vector-based graphics shall be scaled to match display resolution on a typical PC workstation, and all bitmap graphics shall be shown at full resolution.
4. Qualification Data: For factory-authorized EMCS programmer.
5. Secondary Connection Cabinets: drawings to be provided to the customer must contain the following strict criteria:

    a. Equipment orientation and placement of the SCC and the transformer. This is an absolute requirement and must be adhered to in order to ensure the safety of our operating personnel.
    b. Coordinate provision of conductors from the transformer secondary to the SCC with Xcel. Conductor sizing and material shall be as noted on the drawings.
    c. 18" maximum depth conduit/cable trough depth, necessary for operating crews to properly train the cable into the SCC.

1.5 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".

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Install service entrance in accordance with Contract Documents, the Utility Company's rules and regulations, and NFPA 70, National Electric Code (NEC) as adopted and amended by the Denver Building Code.

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C. Coordinate with Xcel Energy "Blue Book" for service entrance, metering, and SCC requirements.

D. Personnel performing modifications to the EMCS shall be trained and factory-authorized by the EMCS software developer, with minimum of (5) years of experience programming and operating the software that comprises the DEN EMCS.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.8 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.
2. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.
3. Do not proceed with interruption of electrical service without DEN Project Manager's written permission.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for all EMCS modifications associated with this project for [**two (2)**] <**Insert number**> years.

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.

1.11 EQUIPMENT FOR ELECTRICITY METERING BY OWNER OR TENANT

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Schneider ElectricUSA, Inc: PowerLogic METSEEM3560.
2. or approved equal.

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B. General Requirements for Owner's/Tenant's Meters:

1. All submetering equipment shall be compatible with the existing BACNet MS/TP EMCS network.
2. Comply with UL 1244.
3. Meters shall have an accuracy of [**0.2**] [**0.5**] percent of reading, complying with requirements in ANSI C12.20.
4. Identification: Provide self-adhesive label on front of meter specifying the metered panel name and/or tenant name, as directed by the DEN Project Manager. Comply with requirements in Section 260553 "Identification for Electrical Systems."
5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application. Provide sensors from the same manufacturer as the associated meter and obtained from the same source.

    a. Type: Split core.

7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
8. EMCS Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to EMCS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.

C. Kilowatt-hour Meter: Electronic [**three**]-phase meters, measuring electricity used.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours and current kilowatt load. Retain accumulated kilowatt-hour in a nonvolatile memory, until reset.
3. Mounting: IEC 60715, TH35/7.5. 35mm x 7.5mm “top hat” style mounting rail.

D. Kilowatt-hour/Demand Meter: Electronic [**three**]-phase meters, measuring electricity use and demand. Demand shall be integrated over a [**15-minute**] interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD, capable of indicating accumulative kilowatt-hours, current time and date, current demand, historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.

E. Metering Enclosures: NEMA 250, [**Type 1**] minimum, with hasp for padlocking or sealing.

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1. Provide [**36 in. H x 18 in. W x 6 in. D**] enclosure with a clear polycarbonate, hinged cover.
2. Provide IEC 60715, TH35/7.5. 35mm x 7.5mm “top hat” style mounting rail(s) within enclosure.
3. Provide PVC or nylon slotted wiring duct with hinged cover, installed on each side and adjacent to each meter module rail for cable management purposes.
4. Provide enclosure with three horizontal rows of DIN rail, and each row measuring at least 14 in. Rows shall be separated vertically by at least 10 in.

F. Data Transmission Cable: Transmit KY pulse data over Class 1 control-circuit conductors in raceway. Data transmission cable shall comply with requirements for BACNet MS/TP data transmission cable. All cables shall be installed in an approved raceway system. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

G. Software: Meter data shall be aggregated in the EMCS. See Part 3 for additional requirements.

PART 2 - EXECUTION

2.1 INSTALLATION OF OWNER OR TENANT METERING

A. Install DIN-mountable meter modules in the associated electrical room as indicated on the drawings.

B. Owner meters shall be installed in new or existing enclosures, as indicated on drawings. Enclosures shall comply with this Section, and the requirements in Section 260533 “Raceways and Boxes for Electrical Systems.”

1. New metering modules may be installed in existing metering enclosures, where existing enclosures meet the requirements of this Section, and where sufficient extra space is available for such installation.
2. All metering equipment shall be installed on DIN rail, with cables neatly trained within cable management pathways inside each enclosure.
3. Maintain physical separation between line-voltage cabling (sensor leads and voltage reference leads) and BACNet MS/TP cabling throughout.
4. Provide dedicated raceway system for BACNet cabling.

C. Install current sensors in accordance with manufacturer’s recommendations. Verify correct sensor orientation.

D. Connect meters to the EMCS using BACNet MS/TP cabling. Comply with Section 260523 “Control-Voltage Electrical Power Conductors and Cables.”

E. Network Connection:

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1. **BACNET Cable, Model WCW-22/3BLU-WC**.

2.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
2. Equipment Identification Labels: Adhesive film labels with clear protective overlay.

B. Owner metering:

1. Provide Equipment identification tag affixed to the front of each metering enclosure in accordance with Section 260553 “Identification for Electrical Systems.” Identification tag shall contain the text [**“OWNER METERING”**].
2. Provide adhesive film labels with clear protective overlay affixed to each individual meter within an enclosure, with identifying information for the associated load as follows:

a. Commercial tenants: Tenant name and panelboard name.
b. DEN Panelboards: Panelboard name.
c. Motors and Equipment: Equipment name or designation.
d.

3. All raceways shall be identified using color-coding requirements as identified in Section 260553 “Identification for Electrical Systems.”

2.3 SOFTWARE MODIFICATIONS

A. Engage the services of a factory-authorized programmer to provide modifications to the EMCS to accommodate the addition of owner meters as required.

B. Provide graphics pages depicting metering data for each meter. Coordinate with the DEN Project Manager and DEN EMCS Administrator for graphics standards. Metering pages shall include the following:

1. Metered load name, in accordance with 3.3(B)(2).
2. Instantaneous Demand (kW), with trend.
3. Usage, month to date (kWH), with monthly summary.
4. Peak Demand, historical (kW).

2.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service

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representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Connect a load of known kilowatt rating, [**1.5**] kW minimum, to a circuit supplied by metered feeder.
2. Turn off circuits supplied by metered feeder and secure them in off condition.
3. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.

C. Electricity metering will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

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 Lump Sum Contract price.

END OF SECTION 262713

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge-suppression units.
4. Isolated-ground receptacles.
5. Snap switches and wall-box dimmers.
6. Cord and plug sets.
7. Floor service outlets, poke-through assemblies, and multioutlet assemblies.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 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.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

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1.5 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.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 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.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Service-Outlet Assemblies: **One for every 10**, but no fewer than **one**.
2. Poke-Through, Fire-Rated Closure Plugs: **One for every five** 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**.

1.9 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' 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).

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2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).
5. Legrand
6. or approved equal.

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 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.

2.3 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.

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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, **p**rovide one of the following:

a. Cooper; TR8300.
b. Hubbell; HBL8300SGA.
c. Leviton; 8300-SGG.
d. Pass & Seymour; TR63H.
e. or approved equal.

2.4 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. Tamper-Resistant GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; GFTR20.
b. Pass & Seymour; 2095TR.
c. or approved equal.

2.5 CORD AND PLUG SETS

A. Description:

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1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

B. 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.

C. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Cooper; 1995L.
   b. Hubbell; HBL1557L.
   c. Leviton; 1257L.
   d. Pass & Seymour; 1251L.
   e. or approved equal.

D. .

2.6 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.

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2.7 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

3.1 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:

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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"
    b. Convenience receptacles: 18”

E. Receptacle Orientation:

1. 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. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. 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.

I. Adjust locations of floor service outlets to suit arrangement of partitions and furnishings.

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3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 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.

3.4 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

4.1 METHOD OF MEASUREMENT

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

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PART 5 - PAYMENT

5.1 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 262726

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SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in **enclosed switches**.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit **in PDF format**.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.
7. Include data substantiating that materials comply with requirements.

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1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit **in PDF format**.
4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to **ten (10)** percent of quantity installed for each size and type, but no fewer than **three (3)** of each size and type.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.7 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.8 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

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1.9 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann.
2. Edison; a brand of Cooper Bussmann.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.
5. General Electric.
6. Gould.
7. Reliance.
8. or approved equal.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, fast acting Class L, time delay Class RK1, fast acting Class RK1, time delay Class J, fast acting Class J, time delay Class T, fast acting.
2. Feeders: Class L, fast acting Class L, time delay Class RK1, fast acting Class RK1, time delay Class RK5, fast acting Class RK5, time delay Class J, fast acting.
3. Motor Branch Circuits: Class RK1 Class RK5, time delay.
4. Other Branch Circuits: Class RK1, time delay Class RK5, time delay Class J, fast acting Class J, time delay.
5. Control Circuits: Class CC, fast acting time delay.

B. Plug Fuses:

1. Motor Branch Circuits: Edison-base type, dual Edison-base type, single Type S, dual Type S, single-element time delay.
2. Other Branch Circuits: Edison-base type, single-element fast acting Edison-base type, dual-element time delay Edison-base type, single-element time delay Type S, dual-element time delay Type S, single-element time delay.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install plug-fuse adapters in Edison-base fuseholders and sockets. Ensure that adapters are irremovable once installed.

C. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

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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 262813

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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Enclosures.

B. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to **ASCE/SEI 7**.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **and the unit will be fully operational after the seismic event**."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and

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manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
7. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Manufacturer's field service report.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

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1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to **ten (10)** percent of quantity installed for each size and type, but no fewer than **three (3)** of each size and type.
2. Fuse Pullers: **Two (2)** for each size and type.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 30 deg F (minus 35 deg C) and not exceeding 120 deg F (49 deg C).
2. Altitude: 5500 feet (1677 m).

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.
2. Indicate method of providing temporary electric service.

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3. Do not proceed with interruption of electric service without DEN Project Manager's written permission.
4. Comply with NFPA 70E.

1.11 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.12 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. or approved equal.

B. Type HD, Heavy Duty, Single Throw, [**240**] [**600**]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate [**specified**] [**indicated**] fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: [**One (1)**] [**Two (2)**] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.

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7. Lugs: **Mechanical** type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.
9. Accessory Control Power Voltage: Remote mounted and powered; [**24-V ac**] [**120-V ac**] [**208-V ac**] [**240-V ac**] [**6-V dc**] [**12-V dc**] [**24-V dc**].

2.2 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.
5. or approved equal.

B. Type HD, Heavy Duty, Single Throw, [**240**] [**600**]-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
4. Auxiliary Contact Kit: [**One (1)**] [**Two (2)**] NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: [**Mechanical**] [**Compression**] type, suitable for number, size, and conductor material.
7. Accessory Control Power Voltage: Remote mounted and powered; [**24-V ac**] [**120-V ac**] [**208-V ac**] [**240-V ac**] [**6-V dc**] [**12-V dc**] [**24-V dc**].

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, **Type 1**.
2. Outdoor Locations: NEMA 250, **Type 3R**.
3. Other Wet or Damp, Indoor Locations: NEMA 250, **Type 4**.

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PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

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C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

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.

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END OF SECTION 262816

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SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. IGBT: Insulated-gate bipolar transistor.

F. LAN: Local area network.

G. LED: Light-emitting diode.

H. MCP: Motor-circuit protector.

I. NC: Normally closed.

J. NO: Normally open.

K. OCPD: Overcurrent protective device.

L. PCC: Point of common coupling.

M. PID: Control action, proportional plus integral plus derivative.

N. PWM: Pulse-width modulated.

O. RFI: Radio-frequency interference.

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P. TDD: Total demand (harmonic current) distortion.

Q. THD(V): Total harmonic voltage demand.

R. VFC: Variable-frequency motor controller.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means, "The unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

1. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Each installed unit's type and details.
b. Factory-installed devices.
c. Enclosure types and details.
d. Nameplate legends.
e. Short-circuit current (withstand) rating of enclosed unit.
f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
g. Specified modifications.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each

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support. Indicate field measurements.

B. Qualification Data: For qualified testing agency.

C. Seismic Qualification Certificates: For VFCs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

D. Product Certificates: For each VFC, from manufacturer.

E. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze designated operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels.

F. Source quality-control reports.

G. Field quality-control reports.

H. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

I. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
5. Manufacturer's installation information including equipment anchorage provisions.

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B. Certified production test reports.

C. Seismic certification.

D. Recommended renewal parts list.

E. Torque Values: Submit torque values for all connections with a torque schedule and witness signature.

F. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Power Fuses: Equal to ten (10) percent of quantity installed for each size and type, but no fewer than three (3) of each size and type.
2. Control Power Fuses: Equal to ten (10) percent of quantity installed for each size and type, but no fewer than of each size and type.
3. Indicating Lights: Two (2) each type and color installed.
4. Auxiliary Contacts: Furnish one (1) spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three (3) spares for each size and type of magnetic contactor installed.

1.9 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. The Manufacturer of this equipment shall have been pre-qualified by Owner.

E. When requested by the DEN Project Manager, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

F. Installers shall specialize in installation of equipment with a minimum of five (5) years of experience.

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G. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

1.10 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:

1. Ambient Temperature Range: Minus 30 deg F (minus 35 deg C) to 120 deg F (49 deg C).
2. Ambient Storage Temperature: Minus 30 deg F (minus 35 deg C) to 140 deg F (60 deg C)
3. Humidity: Less than 95 percent (noncondensing).
4. Altitude: 5500 feet (1677 m) above sea level.

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in 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. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical systems without DEN Project Manager's written permission.
4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

D. Field Measurements: Verify existing dimensions by field measurements. Verify clearances and locate obstructions within manufacturing and installation tolerances of enclosed assemblies

1.12 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:

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1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.
3. Ambient and environmental conditions of installation location.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

D. The drawings are diagrammatic and indicate the general arrangement of electrical work. Locations are approximate and shall be subject to minor modifications as dictated by field conditions and as directed by DEN Project Manager.

1.13 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Minimum five (5) years from date of Substantial Completion.

1.14 CONSTRUCTION WASTE MANAGEMENT

1. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB.
2. Baldor Electric Company.
3. Danfoss Inc.; Danfoss Drives Div.
4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
5. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
6. Rockwell Automation, Inc.; Allen-Bradley Brand.
7. Siemens Energy & Automation, Inc.
8. Square D; a brand of Schneider Electric.
9. Toshiba International Corporation.
10. Yaskawa Electric America, Inc; Drives Division.
11. or approved equal.

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B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: Constant torque and variable torque.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 66 Hz, with torque constant as speed changes; maximum voltage equals input voltage.

G. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding **3** percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: **96** percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: **96** percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: **10** kA.
7. Ambient Temperature Rating: Minus 30 deg F (minus 35 deg C) to 120 deg F (49 deg C).
8. Ambient Storage Temperature Rating: Minus 30 deg F (minus 35 deg C) to 120 deg F (49 deg C)
9. Humidity Rating: Less than 95 percent (noncondensing).
10. Altitude Rating: 5500 feet (1677 m) above sea level.
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability: **1.5** times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
14. Speed Regulation: Plus or minus **5** percent.
15. Output Carrier Frequency: Selectable; 0.5 to **15** kHz.

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16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, **32** bit, isolated from all power circuits.

I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.
2. Signal: Pneumatic.

J. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: **0.1 to 999.9** seconds.
4. Deceleration: **0.1 to 999.9** seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with **three (3)** selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

N. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

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O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

Q. Integral Input Disconnecting Means and OCPD: **NEMA AB 1, instantaneous-trip circuit breaker** with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. **NO** alarm contact that operates only when circuit breaker has tripped.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

    a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last **four (4)** faults with time and date stamp for each.

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D. Indicating Devices: Digital display **and additional readout devices as required,** mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

   a. A minimum of **two** programmable analog inputs: [**0 to 10-V dc** or **4- to 20-mA dc Operator-selectable "x"- to "y"-mA dc**.
   b. A minimum of **six** multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of **one** programmable analog output signal(s) (**4- to 20-mA dc**), which can be configured for any of the following:

   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of **two** programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps

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for pressure, flow, or temperature regulation.

1. Number of Loops: **One (1)**.

G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms **and energy usage**. Communication shall be VIA BACnet IP or BACnet MSTP; settings retained within VFC's nonvolatile memory.

1. Network Communications Ports: Supports Ethernet BACnet IP
2. Embedded Fieldbus EMCS Protocols for Network Communications: BACnet MSTP, 38400 baud minimum **ASHRAE 135 BACnet**; protocols accessible via the communications ports.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of **all** VFCs to less than **5** percent and THD(V) to **3** percent.

B. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per **IEEE 519**.

C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for **Category C2**.

2.4 OPTIONAL FEATURES

Optional feature types and quantities vary considerably among VFC manufacturers. Consult manufacturers for availability and limitations. Features vary according to VFC and motor characteristics and the driven-equipment operating criteria. Retain applicable features in this article; insert others to suit Project. Indicate requirements for and quantities of optional features on Drawings if not included here. These features are normally added-cost items. See "Optional Features" Article in the Evaluations for additional guidance, and consult manufacturers for availability of, and limitations on, other options.

A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications, when overload protection activates.

1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.

B. Damper control circuit with end of travel feedback capability.

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C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.

D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.

E. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

F. Remote digital operator kit.

G. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer **and a notebook computer**.

2.5 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: **Type 1**.
2. Outdoor Locations: **Type 4X**.
3. **Wash-Down** Areas: **Type 4X**, **stainless steel**.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.6 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: **Heavy**-duty, **oiltight** type.

a. Push Buttons: **Covered** types; maintained.
b. Pilot Lights: **LED** types.
c. Selector Switches: **Rotary** type.
d. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Control Relays: Auxiliary and adjustable **solid-state** time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level

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(BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

D. Supplemental **Analog** Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

E. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, **Type 4X** enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

F. Cooling Fan and Exhaust System: For NEMA 250, **Type 1**; UL 508 component recognized: Supply fan, with **composite** intake and exhaust grills **and filters**; **120** -V ac; obtained from **integral CPT**.

G. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in **NEMA ICS 61800-2**.

1. Test each VFC while connected to **its specified motor**.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

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3.2 HARMONIC ANALYSIS STUDY

A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze **possible** operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) **at each VFC** to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

3.3 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Contractor shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in local codes and standards.

C. Examine installation area to assure there is enough clearance to install equipment.

D. Verify that equipment is ready to install.

E. Verify that required utilities are available, in proper location and ready for use.

F. Beginning of installation means installer accepts conditions.

G. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

H. Floor-Mounting Controllers: Install VFCs on 4-inch (100-mm) nominal thickness concrete base. Comply with requirements for concrete base specified in **Section 033000 "Cast-in-Place Concrete."**

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

I. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with

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disconnect operating handles not higher than 79 inches (2000 mm) above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."

J. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

K. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

L. Install fuses in each fusible-switch VFC.

M. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

N. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

O. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

P. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.

Q. Connect bus assemblies and components to wiring system and to ground as indicated and instructed by manufacturer.

R. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those in specified standards.

S. Submit torque values for all connections with a torque schedule and witness signature.

T. Comply with NECA 1.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

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B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices[**and facility's central-control system**]. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. **Test and adjust controllers, components, and equipment.**
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify DEN Project Manager before starting the motor(s).
5. Test each motor for proper phase rotation.

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6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. VFCs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to assist Contractor in performing startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum

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settings do not allow starting of a motor, notify DEN Project Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges **as specified in Section 260573 "Overcurrent Protective Device Coordination Study."**

F. Set field-adjustable pressure switches.

3.9 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

C. Provide final protection to ensure that moisture does not enter assembly.

3.10 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris. Repair damaged finish to match original finish.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to assist Contractor with training Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

1. Train Owner's maintenance personnel on procedures and schedules for starting up and shutting down, troubleshooting, servicing, and maintaining equipment and schedules.

B. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

3.12 COMMISSIONING

A. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of bus assembly including joints and plug-in units.

1. Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.

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2. Perform two follow-up infrared scans of bus assembly, one at four months and the other at 11 months after Substantial Completion.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 PAYMENT

A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 262923

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SECTION 265100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The contractor shall furnish and install all lighting equipment, lighting fixtures, brackets, hangers, lamps, raceway, cable, panels, and transformers as shown in fixture schedule, drawings and as required for all outlets indicated on the drawings.

B. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

C. Related Sections:

D. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
   1. Section 262726 "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

E. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by alternates.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LED: Light Emitting Diode.

F. LER: Luminaire efficacy rating.

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G. Lumen: Measured output of lamp and luminaire, or both.

H. Luminaire: Complete lighting fixture, including ballast/driver housing if provided.

I. "Neon" lighting: A generic term meaning lighting consisting of a gaseous discharge inside a glass tube with cold-leads, subjected to a high voltage supplied by an external transformer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast, including BF.
4. Energy-efficiency data.
5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Action Submittals" Article in Section 233713 "Diffusers, Registers, and Grilles."
6. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
7. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

8. Illumination data with light fixture efficiency, table of zonal cavity coefficients of utilization, recommended maximum spacing-to-mounting ratio and candlepower distribution curves drawn to scale such that candlepower can be scaled at different angles (or provide candlepower data in tabular form at 10-degree increments).
9. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For non-standard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Light fixture shop drawings shall be in booklet form with a separate sheet for each fixture, assembled in "luminaire type" alphabetical or numerical order, with proposed fixture, lamp type, and accessories clearly indicated on each sheet.

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Details indicating compatibility with ceiling grid system are required.

C. Samples: One complete operating unit for each type of interior light fixture when requested by DEN Project Manager. Each Sample shall include the following:

1. Lamps and ballasts, installed.
2. Cords and plugs.
3. Pendant support system.

D. Installation instructions.

E. Substitutions:

1. Substitutions: Under provisions of Division 01. One sample of each proposed light fixture substitution unless the DEN Project Manager waives requirement.
2. Printed physical, electrical, and photometric data clearly highlighted to show the differences between the proposed substitutions and the specified light fixture.
3. Photometric information in IES standard format on a disc and printed on 8½” x 11” pages.
4. Point to point lighting calculation for all typical spaces.

F. "Neon" Lighting:

1. Installation of neon lighting is not allowed without written authorization by the DEN Project Manager.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lighting fixtures.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches (305 mm) of the plane of the luminaires.
4. Ceiling-mounted projectors.
5. Structural members to which suspension systems for lighting fixtures will be attached.
6. Other items in finished ceiling including the following:
7. Air outlets and inlets.
8. Speakers.
9. Sprinklers.
10. Smoke and fire detectors.
11. Occupancy sensors.
12. Access panels.
13. Perimeter moldings.

B. Qualification Data: For qualified agencies providing photometric data for lighting

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fixtures.

C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

D. Field quality-control reports.

E. Maintenance Data: Maintenance data and parts lists for each interior lighting fixture and accessory; including "trouble-shooting" maintenance guide. All data, product data, and shop drawings shall be included in a maintenance manual.

F. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

B. Torque Values: Submit torque values for all connections with a torque schedule and witness signature.

C. As-Built Plans: Submit complete as-built plans of all Work, including interface with other Work, in accordance with requirements as specified in Section 013300 "Submittal Procedures".

1.7 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. LED Fixtures; Three (3) for every 100 but not less than two (2) of each type and rating installed.
2. Non-LED Fixtures: Provide the following:

    a. Lamps: Ten (10) for every 100 but not less than two (2) of each type and rating installed.
    b. Plastic Diffusers and Lenses: **One for every 100** of each type and rating installed. Furnish at least one of each type.
    c. Globes and Guards: **One for every 20** of each type and rating installed. Furnish at least one of each type.

3. Emergency lighting units, emergency battery packs: One for every **20** emergency lighting unit.

1.8 QUALITY ASSURANCE

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A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

C. 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.

D. Comply with NFPA 70.

E. Comply with the requirements of the reference standards noted herein, except where more stringent requirements are listed herein or otherwise required by the Contract Documents. All equipment furnished under this section shall carry a UL Listing.

F. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

G. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.

1. Obtain DEN Project Manager's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

B. The drawings are diagrammatic and indicate the general arrangement of electrical work. Locations are approximate and shall be subject to minor modifications as dictated by field conditions and as directed by DEN Project Manager.

1.10 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

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1. Warranty Period for Emergency Lighting Unit Batteries: Minimum three (3) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining two years.
2. Warranty Period for **Emergency Fluorescent Ballast and Self-Powered Exit Sign** Batteries: Minimum Three (3) years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining two (2) years.

1.11 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide products indicated on drawings, or approved equal.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. General: Lighting fixtures are to be of the sizes, types and ratings required complete with, but not limited to, housings, high power factor ballasts, energy-efficient lamps, lamp holders, reflectors, energy-efficient ballasts, starters, and wiring. Fixtures are to be factory-assembled, with those components required for complete installation. Fixtures with concealed hinges and catches are to have metal parts grounded as a common unit and be constructed to dampen ballast generated noise. Equipment and materials shall bear the UL label.

B. Environmental Conditions: The equipment shall be designed and constructed to operate successfully at the rated values under the following environmental conditions:

1. Location: Indoors.
2. Altitude 5,500 feet (1677 m) above sea level.
3. Ambient temperature range minus 30 deg F (minus 35 deg C) to 120 deg F (49 deg C), for fixtures in unconditioned locations.

C. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

D. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

E. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

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F. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.

G. LED Fixtures: RoHS compliant. Comply with ANSI C78.377 and UL 8750.

H. Metal Parts: Free of burrs and sharp corners and edges.

I. Provide all ferrous metal surfaces with a protective finish having rust inhibiting properties. Painted finishes shall be a minimum of 1.5 mils thick and shall have a balance between hardness and bending properties suitable for the application. White finishes shall have 87% minimum reflectance.

J. Fixtures to be installed in a damp or wet location shall be constructed with proper gasketing and corrosion resistant materials and/or coatings, and have appropriate UL Listing label for wet locations. Construct steel fixture channels, end caps, interior barriers, reflectors, etc. of adequate gauge.

K. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

L. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

M. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation. Minimum unpenetrated thickness shall be 0.35". Polystyrene plastic shall not be permitted. All plastics shall be ETL certified as light stabilized, non-yellowing.

    a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
    b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

N. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:

    a. "USE ONLY" and include specific lamp type.
    b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
    c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
    d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and

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compact fluorescent luminaires.
e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
f. CCT and CRI for all luminaires.

O. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

P. Air-Handling Fluorescent Fixtures: For use with plenum ceiling for air return and heat extraction and for attaching an air-diffuser-boot assembly specified in Section 233713 "Diffusers, Registers, and Grilles."

1. Air-Supply Units: Slots in one or both side trims join with air-diffuser-boot assemblies.
2. Heat-Removal Units: Air path leads through lamp cavity.
3. Combination Heat-Removal and Air-Supply Unit: Heat is removed through lamp cavity at both ends of the fixture door with air supply same as for air-supply units.
4. Dampers: Operable from outside fixture for control of return-air volume.
5. Static Fixture: Air-supply slots are blanked off, and fixture appearance matches active units.

Q. Color Rendering Index: All luminaires furnished as part of the project shall have a minimum color rendering index (CRI) of 80.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than **10** percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 42 kHz or higher.
8. Lamp Current Crest Factor: **1.7** or less.
9. BF: **0.88** or higher.
10. Power Factor: **0.95** or higher.
11. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. Electronic Programmed-Start Ballasts for **T8**, **T5 and T5HO** Lamps: Comply with ANSI C82.11 and the following:

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1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.
2. Automatic lamp starting after lamp replacement.

D. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.

E. Ballasts for Low-Temperature Environments:

1. Temperatures minus 30 deg F (minus 35 deg C) and higher: Electronic type rated for minus 30 deg F (minus 35 deg C) to 120 deg F (49 deg C) starting and operating temperature with indicated lamp types.

F. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.

G. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 1 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 10 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

H. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.

    a. High-Level Operation: 100 percent of rated lamp lumens.
    b. Low-Level Operation: 30 percent of rated lamp lumens.

2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

I. Ballasts for Tri-Level Controlled Lighting Fixtures: Electronic type.

1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.

    a. High-Level Operation: 100 percent of rated lamp lumens.
    b. Low-Level Operation: **30 and 50** percent of rated lamp lumens.

2. Ballast shall provide equal current to each lamp in each operating mode.
3. Compatibility: Certified by manufacturer for use with specific tri-level control system and lamp type indicated.

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2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher unless otherwise indicated.
9. Power Factor: **0.95** or higher.
10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate two (2) fluorescent lamp(s) continuously at an output of at least 700 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.

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1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp in a remote fixture continuously.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type.
5. Housing: NEMA 250, Type 1 enclosure.
6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.6 DRIVERS FOR SOLID-STATE LAMPS

A. Description: Listed, electronic, RoHS compliant, meeting the requirements of ANSI C82.77 and UL 8750.

1. Dimming: Where required. Meet or exceed specified dimming percentage. Provide 4-wire (0-10V DC Voltage Controlled) dimming drivers which meet the following requirements:

    a. Compatible with solid-state devices within the range of 1%-100% of the power supply output.
    b. Meet IEC 60929 Annex E for General White Lighting LED drivers.
    c. Connect to devices compatible with class 2 0-10V analog control protocol.
    d. 0-10V control interface shall be completely isolated from the line-voltage AC power supply.
    e. Available sink current for each driver on the 0-10V interface shall not exceed 1 mA.

2. Temperature rating: Match or exceed environmental requirements.
3. Rated Life: 50,000 hours minimum.
4. Manufacturer's Warranty: Five (5) years minimum.
5. Input voltage range: 120-277 VAC, +/- 10%.
6. Power factor: 0.9, minimum.
7. THD: 10% maximum at full load.
8. Efficiency: 85% minimum at full load.

2.7 EMERGENCY LED POWER UNIT

A. Self-contained. Comply with UL 924, ANSI C78.377, and UL 8750. Emergency power

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unit and associated solid-state light source shall be listed as a complete assembly.

1. Battery: Sealed, maintenance-free, **nickel-cadmium**, **lithium-ion**, or **lithium-polymer type**. All batteries supplied for emergency units shall be of the same type.
2. Charger: Fully automatic, solid-state, constant-current type.
3. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.8 BALLASTS FOR HID LAMPS

A. Electronic Ballast for Metal-Halide Lamps: Include the following features unless otherwise indicated:

1. Minimum Starting Temperature: Minus 30 deg F (minus 35 deg C) for single-lamp ballasts.
2. Rated Ambient Operating Temperature: 130 deg F (54 deg C).
3. Lamp end-of-life detection and shutdown circuit.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than **20** percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Lamp Current Crest Factor: 1.5 or less.
8. Power Factor: 0.90 or higher.
9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.
10. Protection: Class P thermal cutout.

B. High-Pressure Sodium Ballasts: Electromagnetic type, with solid-state igniter/starter. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg C.

1. Instant-Restrike Device (where indicated on drawings): Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts, and mogul sockets up to 150 W.
2. Minimum Starting Temperature: Minus 40 deg F (Minus 40 deg C).

2.9 QUARTZ LAMP LIGHTING CONTROLLER

A. General Requirements for Controllers: Factory installed by lighting fixture manufacturer. Comply with UL 1598.

B. Standby (Quartz Restrike): Automatically switches quartz lamp on when a HID lamp in the fixture is initially energized and during the HID lamp restrike period after brief power outages.

C. Connections: Designed for a single branch -circuit connection.

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D. Switching Off: Automatically switches quartz lamp off when HID lamp strikes.

E. Switching Off: Automatically switches quartz lamp off when HID lamp reaches approximately 60 percent light output.

2.10 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

1. All exit signs shall have green illuminated lettering on a white background.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

a. Battery: Sealed, maintenance-free, nickel-cadmium type.
b. Charger: Fully automatic, solid-state type with sealed transfer relay.
c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

3. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in **battery** for power connection to remote unit.
b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

C. Self-Luminous Signs: Prohibited

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2.11 EMERGENCY LIGHTING UNITS

A. The emergency lighting for the means of egress and exit areas shall be accomplished by the following system:

1. Self-contained, unitized rechargeable battery-powered fixtures shall be connected to existing emergency power supply.

B. General Requirements for Emergency Lighting Units: Self-contained units complying with UL 924.

1. Battery: Sealed, maintenance-free, lead-acid type.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
7. Integral Time-Delay Relay: Holds unit on for fixed interval of **15** minutes when power is restored after an outage.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.12 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 80 (minimum), color temperature 4,100 degrees Kelvin. 3,500 degrees Kelvin lamps shall be used in selected areas as indicated on drawings, or as directed by DEN Project Manager. Average rated life 20,000 hours unless otherwise indicated.

B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 80 (minimum), color temperature 4,100 degrees Kelvin. 3,500 degrees Kelvin lamps shall be used in selected areas as indicated on drawings, or as directed by DEN Project Manager. Average rated life of 20,000 hours unless otherwise indicated.

C. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3,500 degrees

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Kelvin. 3,000 degrees Kelvin lamps shall be used in selected areas as indicated on drawings, or as directed by DEN Project Manager. Average rated life of 20,000 hours unless otherwise indicated.

D. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 3,500 degrees Kelvin. 3,000 degrees Kelvin lamps shall be used in selected areas as indicated on drawings, or as directed by DEN Project Manager. Average rated life of 20,000 hours unless otherwise indicated.

E. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 4,100 degrees Kelvin. 3,500 degrees Kelvin lamps shall be used in selected areas as indicated on drawings, or as directed by DEN Project Manager. Average rated life of 10,000 hours at three hours operation per start[**and suitable for use with dimming ballasts**] unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).
7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

2.13 SOLID-STATE LAMPS

A. LED lamps: ANSI C78.377, listed and rated for the intended environmental conditions.

B. Minimum CRI: 80.

C. Correlated color temperature (CCT): **3500K**.

D. Minimum LED life: 60,000 hours at a lumen output no less than 70% of original output. Lumen maintenance measurements and calculations must conform to IES LM-80 and IES TM-21.

E. Lumen output shall be as specified on the drawings. Conform to IESNA LM-79.

2.14 LIGHTING FIXTURE SUPPORT COMPONENTS

A. All lighting fixture support components to comply with requirements for Seismic Zone 1.

B. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

C. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

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D. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

E. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

F. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

G. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

H. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.15 RETROFIT KITS FOR FLUORESCENT LIGHTING FIXTURES

A. Fluorescent retrofit kits

1. Reflector Kit: UL 1598, Type I. Suitable for two- to four-lamp, surface-mounted or recessed lighting fixtures by improving reflectivity of fixture surfaces.
2. Ballast and Lamp Change Kit: UL 1598, Type II. Suitable for changing existing ballast, lamps, and sockets.
3. **Dimmable LED**option.

B. LED retrofit kits:

1. Universal end brackets construction of a min of 20 gauge powder coated steel secured to host fixture with tek screws
2. Reflector kit: UL classified for use in two to four lamp, surface mounted or recessed light fixtures by improving reflectivity of fixture surfaces.
3. LED and Driver Change kit: UL listed suitable for changing existing ballast, lamps, and socket in existing fluorescent light fixture without voiding existing UL listing
4. Retrofit kit tested to LM80 standards at a min of 60,000 hours
5. **Dimmable LED** option.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sequencing and scheduling: The interior lighting installation is to be sequenced and scheduled with other work to minimize possibility of interference with pipes, ductwork, and conduit. Lighting fixtures shall be protected from damage and soiling during the remainder of construction period.

B. Power Outages: Any power outages necessary to install or test electrical systems and/or equipment shall be coordinated with Denver International Airport

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Maintenance/Engineering. A written shutdown request form shall be submitted to and approved by the DEN Project Manager two (2) weeks prior to the shutdown.

C. Lighting Fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.
3. Set luminaries true, free of light leaks, warps, dents, or other irregularities. Provide the length of stems as required for the luminaries to be level and in the same horizontal plane. Verify the type of all ceilings before bidding, and provide fixtures and mounting to suit. Mount all outlets at position and height to clear equipment, ductwork, piping, etc., in mechanical equipment rooms, storage rooms, etc. Securely fasten all recessed fixtures in suspended ceiling to the ceiling's framing member, as described below.
4. Surface mounting fixtures containing ballasts shall be mounted with a minimum 1-1/2" spacer where mounted on a combustible material unless specifically approved for the application.
5. Protect wiring with tape or tubing at all points where abrasion is likely to occur. Provide chase nipples where field wiring is through knockouts. Wiring in fluorescent fixtures shall be suitable for temperature conditions and in no case less than 90 degree C (194 degree F) rating.
6. Connectors and terminals, including screws and bolts, are to be tightened in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, connectors and terminals are to comply with tightening torques in specified standards and the National Electrical Code. Submit a report of all torquing values with a torque schedule and witness signature to the DEN Project Manager.
7. Surface mounted fixtures greater than 2 feet in length shall be supported at a point in addition to the outlet box fixture stud.
8. Each single phase circuit feeding light fixtures with ballasts shall have a dedicated neutral.
9. Light fixtures in storage areas and fixtures mounted below 8’ shall have a guard to protect the lamps.

D. Emergency Lighting:

1. Emergency lighting fixtures are to be installed at locations and heights per applicable codes. Install in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
2. All emergency lighting conductors are to be routed in a conduit separate from the normal power circuits.
3. All egress areas shall be served by at least (2) lamps.

E. Temporary Lighting: If it is necessary, and approved by DEN Project Manager, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

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F. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

G. Lay-in Ceiling Lighting Fixtures Supports:

1. Supports shall be designed for Seismic Zone 1.
2. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
3. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
4. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
5. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
6. Fixtures are to be securely fastened to structural supports. Individually mounted pendant fixtures longer than 2 feet shall have twin stem hangers. All stem hangers shall have ball hangers and provisions for minimum 1-inch vertical adjustment. Continuous rows of fixtures shall have one additional stem hanger greater than the number of fixtures in the row.

H. Lay-in Lighting System Wiring:

1. Lay-in lighting system shall be hard-piped to J-box. J-box shall not be attached to light fixture. Installed 6’ flexible steel conduit between J-box and fixture. Modular wiring is not permitted. Flex ran from fixture to fixture is not acceptable.

I. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

K. Installation of "Neon" Lighting:

1. Neon lighting is not allowed without written consent from the DEN Project Manager.

3.2 GROUNDING:

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A. Equipment grounding connections are required for interior lighting fixtures. Connections are to comply with tightening torque values specified in UL standards to assure permanent and effective grounds. Submit a report of all torquing values with a torque schedule and witness signature to DEN Project Manager.

3.3 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.5 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.6 DEMONSTRATION:

A. Upon completion of the installation of interior lighting fixtures, and after building circuitry has been energized, the interior lighting system and emergency lighting system shall be operated to demonstrate capability and compliance with requirements.

B. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

3.7 ADJUSTING AND CLEANING:

A. Interior lighting fixtures are to be cleaned of dust, dirt, fingerprints, smudges, and construction debris upon completion of the installation.

B. Installed fixtures are to be protected from damage during the remainder of the construction period.

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C. Occupancy Adjustments: When requested within **twelve (12**) months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to **2** visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of DEN Project Manager.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 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 265100

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SECTION 275123 - EMERGENCY COMMUNICATIONS SYSTEM

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: Microprocessor-switched intercommunications and program systems with the following components:

1. Announcement Control System.
2. Software.
3. Server.
4. Workstation.
5. Visual Display Devices.
6. Monitoring and Testing Systems.
7. Ambient Noise Sensing System.
8. Flight Announcement System.
9. Master Emergency Communication Microphone stations.
10. Microphone stations.
11. Amplifiers.
12. Loudspeakers.
13. Conductors and cables.
14. Raceways.

B. Related Sections:

1. Sections of Division 01 "General Requirements"
2. Sections of Division 26 "Electrical"
3. Sections of Division 27 "Communications"
4. Sections of Division 28 "Electronic Safety and Security"

C. System Overview:

1. The Emergency Communications System (ECS) installed in the Terminal Complex is comprised of a network of audio loudspeakers, as well as textual visual notification systems. The ECS, together with the Fire Alarm system, provides audible and visual mass notification during emergency events.
2. This section covers the emergency communication system, and associated equipment for use in all projects. As such, loudspeakers shall be provided to achieve intelligible audio in all spaces.
3. The ECS also serves as the public address system for the airport, conveying

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pre-recorded and live announcements to all public spaces.

4. The system shall be designed for 24-HR continuous operation.
5. The system shall be designed to maintain the following spare capacity:

    a. Amplifier channels shall have 10% spare capacity, except areas with tenants shall have 20% spare capacity.
    b. Uninterruptible power supplies serving ECS equipment shall be sized to have a minimum of 120% power rating, and a minimum runtime of 2 hours.

D. General Requirements:

1. The Contractor shall provide all licensed and qualified labor, as well as approved material and equipment for the complete installation of the emergency communication system as shown on the drawings and specified herein.
2. The extent of work shall be as shown on drawings, including locations, elevations, and details of construction.
3. Microprocessors, transistors, capacitors, resistors, integrated circuits, printed circuit boards, and other components shall not be operated to exceed their rated values.

1.3 AUDIO SYSTEM DESCRIPTION

A. The ECS audio system shall have the following required operational capabilities:

1. The system is capable of automatic or manual audible testing of microphone inputs, IED headend audio outputs, equalizer outputs amplifiers, and loudspeaker systems.
2. In all Public Areas, the system has the capability of sensing ambient noise sound levels and adjusting loudspeaker zone signal levels up or down accordingly to maintain good speech intelligibility.
3. All inputs and outputs shall be monitored for correct operation. Audio levels of each logical system parameter shall be monitored including but not limited to Microphone Stations, DSP, Amplifiers, loudspeaker lines with impedance and ground faults, and ambient noise system. Other data information of equipment and power monitoring shall be included in monitoring when available. All detected faults shall be displayed on the ECS standard and remote CPU’s.
4. Critical faults shall generate a contact closure for detection by the Fire Alarm System monitor module in HTC, Terminal, AOB, Central Plant, and concourses.
5. All network connections must be monitored by the DEN Network Operations Center. ECS network requirements must be coordinated with DEN Technologies.

B. Manufacturer Limitation:

1. Components provided under this Contract shall be compatible with and connected to the existing Innovative Electronic Designs, Inc. (IED, Inc.) IED 1200vACS located in the center core of each concourse, the Concourse B Regional Jet facility, the Hotel and Transit Center, and Room 45B08 in the

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Terminal.

C. Remote amplification rooms shall be configured to match existing rooms.

D. The Emergency Communications System (ECS) provides paging and background music to all public areas of the airport facilities. Voice paging must be provided to all non-public support areas and parking areas. The system is used for general announcements and emergency announcements throughout Concourses A, B, and C, Terminal, Hotel, Transit Center, AGTS Tunnel, Office Tower and Central Plant.

E. Fixed Passenger Loading Bridges of length greater than 100’ shall be equipped with ECS loudspeakers and Alert Strobes.

F. The emergency announcements functions of the system provide audio evacuation messaging and announcements for the airport. All changes to the system shall be coordinated with the DEN Life Safety and Denver Fire Department before the work begins. An approved shutdown request shall be required to coordinate outages, schedules, hours of work, backup plans, system faults, and system sets and all other aspects of the work. All ECS projects require Fire Alarm Permits as per article 1.4.

G. The system provides ambient noise sensors and monitoring which allow automatic level control of individual loudspeaker zones located in public areas.

H. The monitor/test system is capable of monitoring and/or testing all audio or DC signal, loudspeaker level outputs, or system wiring to insure integrity and reliable operation. All 275114 inputs and outputs must be monitored for correct operation.

I. The ECS shall be integrated with and supplement the facility Fire Alarm System (FAS). The interface with the FAS will enable the use of the ECS’s power amplifiers, and loudspeakers for audible notification. The FAS provides the messages via line level audio signal and FAS contact closures that enable the ECS to broadcast incident-specific messages into pre-designated audio zones.

J. The output of each amplifier must go through a terminal cabinet. This network allows loudspeaker loads to be disconnected from the amplifier outputs for manual measurement of load impedances by maintenance personnel. This shall serve as a demarcation point for trades to test their portion of the work independent of each other.

K. Most loudspeakers operate on a 70 Volt distributed system. Powered loudspeaker arrays are also be permitted. The loudspeakers shall be grouped in modular zones allowing maximum flexibility for paging area assignment. Loudspeaker types shall match DEN current standards to the greatest extent possible. All Gate Podiums, Ticket Counters, Baggage Claim podiums and offices, Fire Command Centers, and Operations Communications Centers must be equipped with microphone stations manufactured by IED, Inc. Match existing configurations for operator continuity between areas.

L. All ambient noise sensors and loudspeakers shall be hardwired to the local P.A. Rooms. Local P.A. Rooms within a building are interconnected via the ECS Ethernet

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Network to the building ECS Control Room. Spare copper and fiber-optic cable for new installations may not exist. Contractor to verify the existence of available cable and cable raceways/conduit. Verify cable requirements with the understanding that fiber optic cabling used for the system is a hardened, redundant cable infrastructure designated as the part of the fire alarm infrastructure.

M. Network Equipment and Design (Directions to Designers) Designers shall meet with DEN Technologies network engineers to determine specific network equipment, architecture and attachment points that are specific to the Project. Network equipment and cabling shall be provided by DEN Technologies. DEN Technologies network staff will operate and maintain the new devices as an integral part of the production ECS network.

N. Terminal cabinets are and shall be used for breakout of loudspeaker wiring home to the equipment racks.

O. Airline and Concessions Tenant ECS requirements: Refer to Emergency Voice Paging System Tenant Revision 275114. It is mandatory for at least one loudspeaker be located in every room and corridor with uniform coverage required in larger spaces.

P. Flight Announcement System shall be provided as required. System shall interface to Owner provided AIDX feed for data to populate the Flight Announcement System with information to automatically or manually announce flight messages at gate or baggage claim areas.

1.4 SUPPLEMENTAL VISUAL NOTIFICATION SYSTEM DESCRIPTION

A. New Airport Terminal Building(s) shall be provided with an emergency voice/alarm communication system fully integrated into the complex-wide Emergency Communication System (ECS), incorporating audible, visual and textual notification appliances including; flight, gate, baggage and multi-use information displays (FIDs, GIDs and BIDs, MUFID), other large format displays and video displays exceeding 60” (25.4mm) measured diagonally. DEN CATV and tenant audio systems shall be shunted upon activation of the emergency communication system

B. All network connections must be monitored by the DEN Network Operations Center. ECS network requirements must be coordinated with DEN Technologies.

C. Supplemental Visual Notification shall be provided as required. Supplemental Visual Notification shall provide visual features of the system including Visual paging and Emergency textual messaging. Supplemental Visual Notification utilizes Multi-Use Flight Information Displays (MUFIDs), baggage information display systems and gate information display systems to display messaging.

D. Video capture/shunt requirements:

1. For dynamic video displays larger than 60” (diagonal), comply with one (1) of the following:

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a. Shunt: Provide fire alarm control module with control relay per Specification 283100 to shunt power.
b. Capture the video display with DEN approved emergency textual messages.
c. Video display must be changed in a way to remove distraction, as approved by DEN Life Safety

2. For static video displays (i.e. menu boards, POS devices, etc.) no action required.
3. For dynamic video displays smaller than 60” (diagonal), except MUFIDS, no action required.

E. For FIDS/BIDS/GIDS, provide ECS capture equipment as defined in 274219 “Multi-User Flight Information Display Systems (MUFIDS)”.

1.5 DEFINITIONS

A. ACS: Announcement Control System.

B. BIDs: Baggage Information Displays.

C. ECS: Emergency Communication System.

D. FIDs: Flight Information Displays.

E. FAS: Flight Announcement System.

F. GIDs: Gate Information Displays.

G. MUFIDs: Multi-User Flight Information Displays.

H. Zone: A group of loudspeakers attached to a single circuit within an amplifier.

I. Zone Group: A group of zones, as defined in the ECS control software.

J. Static Display: Video display showing little or no change over time.

K. Dynamic Display: Video display showing moving images.

1.6 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. A listing of the applicable reference standards is contained in Section 014225 "Reference Standards".

C. In addition to all applicable local and state codes, the work shall be in accordance

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with the latest revisions of all applicable standards and specifications, including the following:

1. Currently adopted City and County of Denver Building and Fire Codes as amended.
2. National Fire Protection Association (NFPA):

    a. NFPA 70, National Electrical Code.
    b. NFPA 72, National Fire Alarm and Signaling Code.

3. National Association of Broadcasters (NAB).
4. International Building Code (IBC).
5. International Fire Code (IFC).
6. EIA: Electrical Industries Association.
7. Underwriters Laboratories (UL):

    a. UL6, Electrical Rigid Metal Conduit – Steel.
    b. UL 464, Standard for Audible Signal Appliances.
    c. UL 797, Electrical Metal Tubing – Steel.
    d. UL 1242, Standard for Electrical Intermediate Metal Conduit – Steel.
    e. UL 1480, Standard for loudspeakers for Fire Alarm, Emergency, and Commercial, and Professional Use.
    f. UL 2572, Standard for Mass Notification Systems.
    g. Other UL Standards shall be applied to ensure that all materials are listed for their intended purpose.

8. United States Access Board (USAB) – Americans with Disabilities Act (ADA) and the 2010 ADA Standards for Accessible Design.

1.7 PERMITS

A. DEN Life Safety Approved drawings and Denver Fire Department Permit is required for all work affecting audio and /or video ECS equipment.

1.8 ACTION SUBMITTALS

A. Provide Submittals in accordance with requirements of Division 01.

B. Product Data: For each type of product indicated.

1. Technical data on each component.
2. Materials list and backbox schedule (including unique backboxes).
3. Include data substantiating that materials comply with requirements.

C. ECS Drawings: For emergency communications system. Include plans, elevations, sections, details, spreadsheets, and attachments to other work.

1. Drawings shall be stamped by a Professional Engineer licensed in the state of Colorado as part of the submittal.

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2. Drawing submittals shall be done on the existing DEN as-builts and clouded to show the scope of work. Drawings in Auto CADD shall have project specific layer(s) showing new work or modifications on its own layer(s) with the project name.
3. Drawings shall be of scale suitable for use for fabrication. They shall show materials, finishes and panel/control markings. Contractor shall make the following submittals:

    a. Shop drawings shall be submitted with information as required by currently adopted NFPA72 and any applicable codes designated per AHJ.
    b. Amplifer load calculations
    c. Level of ambient SPL anticipated for design basis……CODE here
    d. Estimated intelligibility score expected by design.
    e. A complete list of equipment for the systems, including that required for items that are to be fabricated by the Contractor.
    f. A complete set of detailed technical descriptions describing and illustrating all components and materials.
    g. A complete set of shop drawings of items that are to be fabricated by the Contractor and/or which the Contractor intends to fabricate or has fabricated, including but not limited to, the custom panels and receptacle plates.
    h. System block diagrams.
    i. Equipment rack and console layouts.
    j. Details of cable management and termination in terminal boxes junction boxes and equipment racks.
    k. Wiring diagrams showing the exact manner in which the Contractor proposes to install the system. Show all switches, modifications to equipment, control circuits, and equipment rack layouts. Show all equipment/apparatus items that are required for performance of the required functions. Include the following:

        1) Single-line diagram showing interconnection of components.
        2) Cabling diagram showing cable routing.

    l. Drawings identifying all terminals, wiring color-coding and control functions.

4. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection. They shall show materials, finishes and panel/control markings.
5. Microphone Station Schedule including the following information:

    a. Station number.
    b. Location.
    c. Station model number.
    d. Station mounting.
    e. Handset type.
    f. IP address.

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g. Identity of associated parent station, if applicable.
h. Fiber optic transceivers if necessary.

6. Equipment design considerations for future expansion, when indicated.
7. Description of system operation.
8. A complete list of equipment for the systems, including that required for items that are to be fabricated by the Contractor.
9. Equipment rack and console layouts.
10. Zone programming table with microphone station programming for each location.
11. Details of cable management and termination in terminal boxes, junction boxes, and equipment racks.

D. The data submitted by the Contractor shall be sufficiently detailed to enable the Owner's Representative to determine whether the equipment, materials, and installation that the Contractor proposes to furnish comply with the requirements of this specification, and whether or not the Contractor's organization is qualified by experience, and by capability of personnel, to execute the work described herein.

1.9 INFORMATIONAL SUBMITTALS

A. Spreadsheet of all IP devices, their functionality, model number, and location with placeholders for Owner to provide IP address, Masking, port assignment, switch name and default gateway assignments. Templates are available upon request. Also, include POE power requirements and the equipment room that the supporting network switch is located.

B. Qualification Data:

1. Qualifications shall be provided for installer as required in Quality Assurance, 1.9 A.

C. Field Quality-Control Reports. Submit quality reports throughout project as decided in Pre-Construction Meeting. Include communication room conditions, loudspeaker testing information, test and inspection reports as detailed in section 3.12 A, infrastructure connectivity quality and power outage coordination to prevent power issues from damaging installed equipment.

1.10 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. A record of Owner's equipment-programming option decisions.
2. Factory-prepared operation and service manual for each system.
3. Contractor shall provide technical information for all electronic apparatus, including but not limited to schematic diagrams and parts lists, manufacturer's installation instructions, operating instructions and technical specifications.

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4. All system spreadsheets, shop drawings prepared and used by the Contractor, as-built drawings, and any other documents which were used in construction or programming, even if not required to be submitted for approval. This shall include, but not be limited to, wiring diagrams, schedules for identification of building wiring and installation details useful to a maintenance technician.
5. Instruction Manuals:

    a. Provide one (1) hard copy and one (1) electronic copy of an Instruction Manual containing the following:

        1) Table of Contents.
        2) Instructions for operating the system in all modes of operation and for fulfilling all functional requirements.
        3) List of settings and adjustments for semi-fixed controls.
        4) Manufacturer's sheets of specifications, operating instructions and service information arranged alphabetically by manufacturer and then by model number.
        5) Complete detailed wiring diagrams and one-line diagrams for the "as-built" system in reproducible format.
        6) Recommended preventive and remedial maintenance.
        7) Complete parts list.

6. Tenant User Manuals:

    a. Provide ten (10) hard copies and one (1) electronic copy of Tenant User Manual. They shall include the following information:

        1) Basic description of equipment and its functions.

7. As-Built Documents: Two (2) weeks prior to final acceptance testing, the Contractor shall provide two (2) sets of "as-built" prints, and one (1) electronic copy of the following:

    a. System block diagrams.
    b. Equipment rack and console layouts.
    c. System wiring diagrams.
    d. Test reports, as specified herein.
    e. Written warranty, as specified herein.
    f. As-Built drawings in AutoCAD shall have project specific layer(s) showing new work or modifications on its own layer(s) with the project name. New work shall be shown in a dark lineweight, with existing conditions shown in a light lineweight.

8. Project Record:

    a. Provide As-Built drawings in accordance with NFPA 72, “Record Drawings”.
    b. Provide Record of Completion in accordance with NFPA 72, “Record of Completion”.
    c. Provide project information on USB flash drive, or format as requested by

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DEN Project Manager.

d. Provide two (2) ANSI C sized printed copies and (2) electronic copies on USB flash drives, or format as requested by DEN Project Manager with electronic files to DEN Life Safety.

9. Field Documentation:

a. Provide laminated information sheets of new zone or message information for new operating positions at the gates. Include simple microphone station use directions.

1.11 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturers' Qualifications: Paging control system, microphone stations, amplifiers, ambient noise system equipment, monitoring hardware shall be manufactured by:

a. AtlasIED (formerly known as Innovative Electronic Designs, Inc.) (IED).

2. Contractor's Qualifications:

a. Installers for ECS system components shall have a current Denver Fire Department mass notification system Installer’s License and a manufacturer certification.

1) Installers working on both ECS and Fire Alarm systems shall also have a Fire Alarm Installer’s License from the City and County of Denver Fire Department (DFD), in addition to the licensing requirements stated above.

b. The ECS shall be installed by a Contractor who has been regularly engaged in the installation of electronic equipment for at least five (5) years and certified to install IED Voice Paging Systems.

c. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.

3. A resume of qualifications shall be submitted with the Contractor’s bid indicating the following:

a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

b. A technical resume of experience for the Contractor’s Engineer and on-site installation foreman who will be assigned to this project.

c. Similar documentation will be required of any subcontractor who will assist the Contractor in performance of this work. All proposed subcontractors must demonstrate equal or superior experience or technical qualifications to the Contractor in order to contract for any part of the installation or

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testing of the system.

4. Contractor shall be an authorized installer and dealer of the specified equipment with a service facility within 100 miles of the project site.
5. Contractor shall submit proof that the primary system programmer has attended a programming school hosted by the manufacturer of the computerized systems to be provided under this section, and is proficient in the current version of the system.

B. Warranty:

1. Provide a written two (2) year warranty, signed by the Contractor, beginning on the date of Substantial Completion.
2. Include the following provisions:

   a. Contractor shall provide initial response within 2 hours by phone and 4 hours on site.
   b. Warranty issues shall be addressed until resolved.
   c. Warrant all equipment and the installation to be free of faulty workmanship.
   d. Warrant all components, including solid state devices, to be free of defects for a period of two (2) years from the date of final acceptance.
   e. Paint and exterior finishes, fuses and lamps are excluded from the above warranty, except when damage or failure results from defective materials or workmanship covered by the warranty.

1.12 COORDINATION

A. Coordinate layout and installation of ceiling-mounted loudspeaker and ambient noise sensor microphones with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate installation with existing DEN systems (i.e., telecommunications, security, fire alarm, etc.). Notify DEN Project Manager promptly of any conflicts that are identified.

1.13 EXTRA STOCK

A. Contractor shall supply spare parts to the Owner in the amount of 10% of the equipment installed under this contract or one of each item, whichever is greater.

B. All spare stock shall be delivered in the manufacturer’s standard shipment packaging and turned over to the DEN Project Manager, and each item shall be clearly identified as to the package contents and what project or area the item was used. Spare parts are provided for owner’s emergency use and not to be relied upon for contractors’ warranty usage. loudspeaker types used that are not listed shall be provided with a unique identifier. Include the following:

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1. Storage cabinets.
2. Announcement Control System (ACS) Computers.
3. Graphical User Interfaces
4. Digital Signal Processors
5. Audio Mixers
6. Input / Output modules.
7. Microphone Stations (of each type, Podium, Jetway, Main).
8. Microphone Handsets.
9. Type S1 Loudspeaker.
10. Type S2 Loudspeaker.
11. Type S3 Loudspeaker.
12. Type S4 Loudspeaker.
13. Type S5 Loudspeaker High Frequency Horn Driver Diaphragm Replacement Kits.
14. Type S5 Loudspeaker 10-inch Midrange Cone Drivers.
15. Type S6 Loudspeaker.
16. Type S7 Loudspeaker.
17. Type S8 Loudspeaker.
18. Type S9 Loudspeaker.
19. Type S10 Loudspeaker.
20. Type S11 Loudspeaker.
21. Other types of loudspeakers.
22. Amplifier Cards (of each type used).
23. Fuses (of each type/size used in system).
24. Relays of each type and size used in the system.
25. Connectors (of each type used in system).

1.14 CONSTRUCTION WASTE MANAGEMENT

A. Construction waste shall be managed in accordance with provisions of Section 017419 "Construction Waste Management and Disposal". Documentation shall be submitted to satisfy the requirements of that Section.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials, equipment, and apparatus provided shall be new and of the latest design or model offered for sale by the approved manufacturer.

B. Acceptability for use in the systems shall be determined by DEN Life Safety. Such items shall be installed only after receipt of written approval of the DEN Project Manager.

C. All products shall be compatible with the existing system.

D. All products shall be rated for continuous (24-hour, 365-day) use.

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2.2 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 and Outdoors.
2. Altitude: 5,500 feet (1677 m) above sea level.
3. Ambient Temperature Range: Minus 30 deg F (minus 35 deg C) to 120 deg F (49 deg C).

2.3 ANNOUNCEMENT CONTROL SYSTEM (ACS)

A. The ACS shall provide system setup, control, and messaging for the PA system and integrate with the existing systems at DEN in order to provide a fully functioning and monitored system.

B. ACS shall be capable of managing 240 microphone stations and 65,536 zone outputs per unit.

C. ACS shall provide 8 x 8 message system expandable to 64 x 64 of pre-recorded messages via the use of additional message controller(s).

D. ACS shall provide up to 180 simultaneous announcements and messages over a single LAN or VLAN.

E. ACS shall provide the following:

1. Fully redundant architecture over standard LAN.
2. System backup and restoration configuration files.
3. Built-in wizards for initial setup.
4. Integrated visual paging support.
5. Event messaging allowing multiple actions or events to be triggered.
6. Multi-Language support for different language packages or second language requirements as defined in the specification.

F. Manufacturer:

1. IED IP 100 Series Software. Include hot standby backup for each primary controller.
2. or approved equal.

2.4 AMBIENT NOISE SENSING SYSTEM

A. Ambient Noise Sensor Collector shall be provided for noise sensor termination from the field devices. Collector shall be used with Titan 9160 amplifier system exclusively. Collector shall:

1. Be PoE device or connect to local 48Vdc power supply.
2. Connect 32 ambient noise sensors on each frame.

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3. One (1) RU and rack mountable.

B. Manufacturer:

1. IED T9032NS with IED 540S-2 Sensor on 2-Gang Plate.
2. or approved equal.

2.5 AUTOMATIC TEST AND MONITOR SYSTEM

A. The Automatic Test and Monitor System shall provide for self-diagnostics that operate in real time under software control. This self-testing shall include testing of logic, audio operation, power supplies, and power amplifiers. This test shall be automatic and utilize only one system as the interface for the test. Results shall be logged on the PC and a fault list generated that can be printed for the Owner Maintenance staff.

B. System shall report results of actual audio signals being routed through the entire system as well as loudspeaker impedance load changes, loudspeaker ground faults and End of Line loudspeaker faults.

C. System faults shall be reported through software with clearly labeled information and through external interfaces to other systems, via RSS feeds, contact closures, or network messages.

D. System shall collect information from internal IED test and monitoring devices in hardware and report faults or settings.

E. System shall allow circuit testing and reset of corrected fault.

F. Manufacturer:

1. 610 Monitor/Test Software for the system server.
2. 596SGFI Dual Channel sensors for loudspeaker lines.
3. 596EOL loudspeaker end-of-line sensor as required by Designer.
4. or approved equal.

2.6 MICROPHONE PAGING STATIONS

A. General:

1. Microphone stations shall originate announcements into zone groups as determined by the DEN Project Manager.
2. Any microphone page station shall be capable of being programmed into any zone group.

    a. Microphone stations shall be capable, when so programmed, of making emergency zone group announcements, terminal zone group announcements, local zone group announcements, and multi-local group announcements.
    b. When so programmed, they shall also be capable of performing any or all

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of the control functions for pre-recorded and assembled messages.

1) These control functions shall include initiating a playback sequence, interrupting a playback sequence, recording a message, monitoring a message, or playing back a message to its own multi local group, or to a terminal zone group instead of to the zone map assigned to that message.

3. The microphone stations shall include a microphone; either handheld, handset or gooseneck-mounted type.
4. Each microphone station shall have buttons for zone group selection to activate that microphone station for announcements into pre-programmed zones.

   a. Green and Red LED's shall indicate ready or busy respectively. Any 5-second pause after the green LED has illuminated shall terminate the announcement.

5. Each station shall include its own microphone preamplifier, test oscillator, compressor, and balanced output line amplifier for driving long lines without appreciable high frequency loss.

   a. The ACS microprocessor, under software control shall continuously interrogate all active microphone and telephone page stations for requests.

6. Specifications – Total System, Direct Microphone Station input to Zone Output:

   a. Frequency Response: 0.5dB 20Hz - 20kHz.
   b. Total Harmonic Distortion (THD): **< .05% @ +24dBm 20Hz - 20kHz.**
   c. Noise Referred to Input: -125dBv 20Hz - 20kHz.
   d. **Signal-to-Noise (limited by input amp):** > 80dB.
   e. Gain, Adjustable at each paging station: 65dB Maximum.
   f. Maximum Output Level: +24.0dBm.
   g. Normal Output Level: +2.0dBm.
   h. High-pass filter in mic station defeated.

B. Full function Communication Stations:

1. Stations shall have a 12-button keypad for data entry, (8) soft function keys and a color graphical LCD.
2. The station shall be a network appliance with control and CobraNet audio communicating on the audio network.
3. Connection to the system shall be 100BaseT with power provided by a PoE switch port or PoE mid span power.
4. Microphones shall be provided as handheld or gooseneck as required.

   a. Each microphone shall utilize a magnetic mount and include a line amplifier in the microphone shell to eliminate microphone signal levels beyond the microphones.

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5. Each station shall support the connection of up to three 528SK Sidekick expansion stations.
6. Stations shall be provided in vertical, horizontal, surface, flush, or desktop as noted on the drawings and based on the mounting situation required.
7. Acceptable Products:

    a. Horizontal Communications Station:

        1) IED 528HFM-H.
        2) or approved equal.

    b. Vertical Communications Station:

        1) IED 528VFM-H.
        2) or approved equal.

C. Microphone Communication Station Enclosures:

1. For station mounting locations requiring desktop, angled vertical, or angled horizontal, provide factory enclosures to match the finish of the station. Enclosures shall be non-metallic and include rubber feet.
2. Acceptable Products:

    a. IED 528VBB or 528HBB.
    b. or approved equal.

D. Master Emergency Communications Systems Microphone Station (MECSMS):

1. Microphone station shall be complete with integral 17- inch touchscreen monitor computer workstation and graphics user interface per DEN Standards. MECSMS shall provide:

    a. Standard Microphone station as required.
    b. Graphical User Interface (GUI) developed for project.
    c. GUI software application for microphone zone selection and message playback.
    d. Message selection and de-selection.
    e. Live page capabilities.
    f. Acceptable Products:

        1) IED 528 series with touchscreen workstation IED 591D.
        2) or approved equal.

E. Expansion Microphone Communication Station:

1. Expansion stations shall act as an intelligent slave station to a full function station.

    a. Expansion stations shall include (4) soft function keys that can be programmed for operations independent of the master station to which it is connected. This shall allow flight announcements and other cued

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messages to be controlled from the expansion location.

b. Microphones shall be provided as handheld and include a line amplifier in the microphone shell to eliminate microphone signal levels beyond the microphone.

c. The station shall mount in a standard 2-gang wall box and connect to the full function station with Cat5e cable and RJ45 modular connectors.

2. Acceptable Products:

a. Expansion Communications Station IED 528SK.

b. or approved equal.

F. Rack Communications Station:

1. Rack Communication Stations shall have a 12-button keypad for data entry, eight (8) soft function keys and a color graphical LCD.
2. The station shall be a network appliance with control and CobraNet audio communicating on the audio network.
3. Connection to the system shall be 100BaseT with power provided by a PoE switch port or PoE mid span power.
4. Microphones shall be handheld and utilize a magnetic mount. It shall include a line amplifier in the microphone shell to eliminate microphone signal levels beyond the microphones.
5. The station shall include a flush loudspeaker for monitoring selected audio.
6. The loudspeaker shall be powered by an 8-watt power amplifier and include a panel volume control.
7. The station shall use no more than four (4) standard rack units.
8. Acceptable Products:

a. IED 528SRM-H Rack Communications Station.

b. or approved equal.

2.7 EXTERNAL SYSTEM INTERFACE

A. An external interface shall be provided to allow interfacing contact inputs or outputs into the ACS system from the Fire Alarm System, Video displays, or other systems. Each interface shall provide 64 input closures and output closures or voltage ports in groups of 8.

B. Acceptable Products:

1. IED T9032LVIO, T9064LVIO, PoE required.
2. or IED T9040NLR.
3. or approved equal (model and quantity as required).

2.8 POWER AMPLIFIERS

A. Integrated Digital Power Amplifier System (IDPAS): The Integrated Power Amplifier System shall provide DSP processing and power amplification for up to (16) zones in

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a single modular mainframe.

1. Digital Audio Network Interface:

    a. The network interface shall receive (32) dynamic assigned audio channels from the ACS via the Ethernet Network. Control for the IDPAS and monitoring shall be included on the network. The NIC shall provide dual outputs to support a redundant network.

2. Zone Manager:

    a. The IDPAS shall provide zone management for (16) channels as directed by the ACS. Channel management shall be structured to utilize the minimum channels necessary on the network to support paging, messaging and background music activity for any combination of zones.

3. DSP Processing:

    a. The IDPAS shall include digital signal processing for (16) channels of audio. Each channel shall include (9) bands of parametric equalization, time delay, ambient analysis control, (7) monitoring points, and (7) testing points. Complete setup and control software shall be integrated within the Enterprise Software and available on the network for configuring, controlling, monitoring, and testing the DSP for each channel.

4. Ambient Analysis and Control:

    a. The Ambient Analysis System shall adjust signal levels in response to either ambient noise levels or computer commands. The system shall operate in real time and shall not be a “sample and hold” system. The system shall include an automatic calibration sequence. All setup, configuration, and monitoring controls shall be software based with the ability for multiple sensors averaged to control a single channel(s) or for a single sensor to control multiple channels. The sensors shall utilize control signaling and levels that allow co-locating with the loudspeaker cable for cable routing efficiency. Three (3) modes of operation shall be possible:

        1) Automatic: Changes attenuation levels in response to noise levels reported by remote sensors.
        2) Slaved: Changes attenuation levels based on remote sensors of an automatic channel.
        3) Fixed: Fixed attenuation as set by the computer and user.

5. Power Amplifier Cards:

    a. Each IDPAS mainframe shall be designed to accept (9) amplifier cards.
    b. Each card shall be removable and replaceable without disabling or interfering with the operation of the DSP or other power amplifier cards.
    c. The amplifier cards shall be available as dual 200-watt cards or single 400-watt cards, and shall be of a high efficiency design to maintain a

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minimum of 78% efficiency at 100% output.

d. The mainframe shall support simultaneous use of (8) amplifier cards (16 channels) plus the hot spare card.
e. Provide appropriate card models as required.

6. Automatic Backup Amplifier Switching:

a. The 9th power amplifier slot shall be reserved for automatic backup amplifier switching.
b. A matching amplifier card shall be installed as a hot spare amplifier in the event of failure of one of the primary amplifiers.
c. The system shall detect a failure of an amplifier card and shall electronically replace that amplifier without loss of service.
d. Switching shall result in no loss or change of source or destination routing. Detection and switching shall take place in less than 2 seconds.
e. A failure shall be reported immediately to the fault logging system.

7. Internal Monitoring:

a. Each IDPAS shall include an internal audio monitoring buss with software selected switching.
b. This monitor shall allow selection of a monitor point from the control software to allow visual and audio monitoring of the channel network input, channel direct input, ambient channel output, EQ output, amplifier input, amplifier output, and loudspeaker load monitor for each of the (16) channels.
c. This feature shall operate simultaneously and independent of the automatic testing.

8. Automatic Testing:

a. The automatic testing system shall locally test and process audio test signals through the IDPAS.
b. These tests may be done manually on demand for any single test point as well as globally in the mainframe on a completely automated basis during the day.
c. The test points duplicate those of the monitoring points above with a testing resolution of 0.5 dB.

9. Local Inputs:

a. The IDPAS shall include (16) analog inputs for local zone program sources or BGM. One channel shall be configurable as a backup emergency input usable in the event of a network failure.
b. Acceptable Products:

1) Integrated Amplifier Mainframe: IED T9160L, or approved equal.
2) Dual 200 Watt 70-Volt Amplifier Card: IED T6472L, or approved equal.
3) 400 Watt 70-Volt Amplifier Card: IED T6471L, or approved equal.

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4) or approved equal.

2.9 END OF BRANCH SUPERVISION

A. The end of branch supervision module shall enhance the loudspeaker line supervision functions of the system. The module shall be capable of monitoring multiple end of branch locations on a single circuit. Module shall include:

1. Supervision of 70 and 100 volt loudspeaker lines without the need for a return wire.
2. Unique ID number for identification in the system monitoring software.
3. Proof that cable is intact to the end of the circuit.

B. Manufacturer:

1. IED T597EOB, IED T596EOL (for end of Line).
2. Or approved equal.

2.10 UNINTERRUPTABLE POWER SUPPLY (UPS)

A. Provide UPS in accordance with Section 263353 "Static Uninterruptible Power Supply".

B. A UPS shall be supplied for critical components of the PA system including the ACS, microphone stations in Fire Command Centers and Communication Centers, and amplifier frames to insure uninterrupted service and control of the system.

C. UPS shall be rack-mounted device with 24 hours standby and 15 minutes of operation at full load. Monitor LAN connection for supervision of unit.

2.11 LOUDSPEAKERS

A. General: Loudspeaker design shall be provided to meet the requirements of the currently adopted edition of NFPA72 – “Notification Appliances”. Match Existing loudspeakers in areas if Project includes additions or remodels.

B. Type S1, Full-Range Paging Loudspeaker, Flush Mount with grille:

1. Loudspeaker Type S1 shall be a 6.5- inch diameter coaxial device UL 2043 with a minimum input sensitivity of 88 dB measured at 1 meter with 1 watt input from 500 Hz to 2.5 kHz, frequency response shall be ± 7 dB, 63 Hz to 20 kHz and the coverage angle shall be a nominal 90 degrees conical from 500 Hz to 2.5 kHz.

   a. The loudspeakers shall be rated for 32 W minimum and shall include a 70 V line matching transformer, with 0.5 dB maximum insertion loss over the frequency range of 100 Hz to 15 kHz and selectable level taps at 2, 4, 8, 16 and 32 watts, which shall be wired in parallel with the voice coil.
   b. Type S1 loudspeakers shall be suitable for mounting in suspended tile or

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drywall and shall be an integrated flush mounted loudspeaker enclosure, 8.5- inches minimum depth x 12.5- inches wide.

2. These loudspeakers shall be utilized in public areas with suspended tile or drywall ceiling height of 15 ft. or less.
3. Manufacturer:

    a. Atlas FAP62T with integrated back can, grill and suspension system.
    b. or approved equal.

C. Type S2, Full-range Paging Loudspeaker, Flush Mount behind perforated metal ceiling:

1. Loudspeaker Type S2 shall be a 4- inch diameter coaxial device with a minimum input sensitivity of 88 dB measured at 1 meter with 1 watt input from 500 Hz to 2.5 kHz, frequency response shall be ± 7 dB, 75 Hz to 20 kHz and the coverage angle shall be a nominal 90 degrees conical from 500 Hz to 2.5 kHz.

    a. The loudspeakers shall be rated for 16 W minimum and shall include a 70 V line matching transformer, with 0.5 dB maximum insertion loss over the frequency range of 100 Hz to 15 kHz and selectable level taps at 1, 2, 4, 8 and 16 watts, which shall be wired in parallel with the voice coil.
    b. A mounting ring shall be provided to secure the loudspeaker to the enclosure. Standard grilles will not be used behind perforated metal.
    c. All other specified requirements apply as stated.

2. Perforated metal ceiling materials must have at least 80% opening to avoid affecting loudspeaker performance or intelligibility.
3. These loudspeakers shall be utilized in public areas with perforated metal ceiling at a height of 15 ft. or less.
4. Manufacturer:

    a. Atlas FAp42T and support.
    b. or approved equal.

D. Type S3, Two-way Curbside Paging Horn:

1. Loudspeaker Type S3 shall be a two-way device with a compression driver and folded high frequency horn, coupled through a crossover network to a horn-loaded woofer.

    a. The frequency response shall be ± 5 dB, 190 Hz to 18 kHz with low frequency cut-off at 200 Hz.
    b. The input sensitivity shall be 111 dB at 1 meter with 1 watt pink noise input from 400 Hz to 5 kHz.
    c. The loudspeaker shall be rated for 30 W with 250 Hz to 5 kHz pink noise signal with a 6 dB crest factor for a period of eight hours.
    d. The low-frequency horn shall be constructed of reinforced fiberglass and the high frequency horn of die-cast aluminum finished in white.
    e. The horn shall produce a 63 degree horizontal by 85 degree vertical

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coverage pattern at 2 kHz.

f. The loudspeaker shall be provided with a 70 Volt line matching transformer with 3.75, 7.5, 15 and 30 watt taps and bracket to allow aiming.
g. The loudspeaker shall be suitable for mounting to a 4- inch octagonal electrical box.

2. These loudspeakers shall be utilized on Terminal levels 4, 5 and 6 curbsides.
3. Manufacturer:

a. Penton MSH30T.
b. or approved equal.

E. Type S4, 12- inch Coaxial Loudspeaker:

1. Loudspeaker Type S4 shall be a high quality two-way loudspeaker system, consisting of a constant directivity horn, coaxially mounted in front of a cone transducer.

a. The overall frequency response shall be ± 3 dB, 100 Hz to 15 kHz and the loudspeaker shall be rated for 150 W continuous pink noise.
b. The low frequency transducer shall be 12- inches in diameter with an input sensitivity of 99 dB at 1 meter with 1 watt averaged from 500 Hz to 2.5 kHz.
c. The high frequency driver/horn shall have a symmetrical coverage pattern of 90 degrees between 1 kHz and 10 kHz and a sensitivity of 110 dB at 1 meter with 1 watt input averaged from 2 kHz to 10 kHz.
d. Type S4 assemblies shall be provided with a passive crossover with a crossover frequency of 1.5 kHz.
e. A 70 Volt line matching transformer, with 0.5 dB maximum insertion loss over the frequency range of 100 Hz to 15 kHz and 7.5, 15, 30 and 60 watt taps, shall be wired in parallel with the voice coil.
f. The assembly shall be suitable for mounting in a (3) cubic foot square enclosure provided under another contract.
g. A square 22 gauge steel grille shall be provided which can be mounted to enclosures in the Terminal airline ticketing areas or in the Concourse ceilings.

2. These loudspeakers shall be flush mounted above the airline ticket counters in the Terminal and flush mounted in the Mezzanine level ceiling structure down the center of the Concourses at a height of approximately 32 ft.
3. Manufacturer:

a. Atlas 12CX with Q4812 Back box and mounting hardware.
b. or approved equal.

F. Type S5, Ceiling Loudpeaker

1. Loudspeaker Type 5 shall be a two–way coaxial loudspeaker with a constant directivity horn mounted in a backcan with supports and grill assembly.

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a. Unit shall be flush mounted in ceiling and supported with a safety cable to structure above besides normal means and methods.
b. Loudspeaker shall be 92dB 1W/1M with a frequency response of 60Hz 0-15kHz +/- 5 dB. loudspeaker shall have a an internal 70/100 volt transformer with taps of 7.5, 15, 30 and 60 watts including an 8 ohm setting.

2. These loudspeakers shall be installed in new high ceiling areas in lieu of the 12-inch loudspeakers in the center of the concourses.
3. Manufacturer:

a. Atlas FAP8CXT with mounting hardware.
b. or approved equal.

G. Type S6, Paging Horn:

1. Loudspeaker Type S6 shall be a high power paging horn consisting of a compression driver and an aluminum re-entrant horn flare with a symmetrical dispersion angle of 100 degrees.

a. The frequency response shall be ±10 dB, 300 Hz to 6,500 Hz at the minimum, with a sensitivity of 107 dB at 1 meter with 1 watt 1 kHz input.
b. Type S6 units shall have a power rating of 30 W and shall be supplied with a transformer with 4, , 7.7, 15 and 30 watt taps.
c. An adjustable mounting bracket shall be provided which is suitable for mounting to a 4- inch octagonal electrical box and allows aiming of the device.

2. These loudspeakers shall be used in the Terminal Parking Garage, the AGTS Tunnel, Central Plant, mechanical rooms and other high noise environments.
3. Manufacturer:

a. Atlas AP30T with APXB-N Base.
b. or approved equal.

H. Type S7, Paging Horn with Dual Horn Flares:

1. Loudspeaker Type S7 shall be a high power paging horn consisting of a single compression driver, coupler and two aluminum re-entrant horn flares with a symmetrical dispersion angle of 100 degrees.

a. The frequency response shall be ±10 dB, 250 Hz to 12,500 Hz with a sensitivity of 101 dB at 1 meter with 1 watt input swept from 500 Hz to 2.5 kHz.
b. The loudspeakers shall have a minimum power rating of 30 W and shall be provided with a 70 Volt line matching transformer wired in parallel with the voice coil with 4, 7.5, 15 and 30 watt taps.
c. An adjustable mounting bracket shall be provided that is suitable for mounting to a 4-inch octagonal electrical box and allows aiming of the device.

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2. These loudspeakers shall be used in the AGTS Tunnel and in the Central Plant.
3. Manufacturer:

    a. Atlas APT-34AT with APXB-N Base.
    b. or approved equal.

I. Type S8, 4-inch Paging Loudspeaker, Flush Mount:

1. Loudspeaker Type S8 shall be a 4- inch general paging loudspeaker with a frequency response of ±1.5 dB, 100 Hz to 10 kHz, an input sensitivity of 94 dB at 1 meter with 1 watt input swept from 500 Hz to 2.5 kHz.

    a. The loudspeaker shall be rated for 15 W minimum and shall be supplied with a 70 Volt line matching transformer with 0.5, 1, 2 and 4 watt taps.
    b. The insertion loss of the 70 Volt transformer shall be 1 dB maximum over the frequency range of 100 Hz to 12 kHz.
    c. The loudspeakers shall be suitable for recess mounting in a standard 4-inch recessed mounted loudspeaker round enclosures provided under another contract. A white, 22 gauge steel loudspeaker grille shall be provided.

2. These loudspeakers shall be flush mounted in suspended tile and drywall ceilings in non-public areas of the Airport buildings.
3. Manufacturer:

    a. Atlas FAP42T or FAP42TC and support.
    b. or approved equal.

J. Type S9, 4-inch Paging Loudspeaker, Surface Mount:

1. Loudspeaker Type S9 shall be a 4-inch general paging loudspeaker with a frequency response of ±1.5 dB, 100 Hz to 10 kHz, an input sensitivity of 94 dB at 1 meter with 1 watt input swept from 500 Hz to 2.5 kHz.

    a. The loudspeaker shall be rated for 15 W minimum and shall be supplied with a 70 Volt line matching transformer with 0.5, 1, 2 and 4 watt taps.
    b. The insertion loss of the 70 Volt transformer shall be 1 dB maximum over the frequency range of 100 Hz to 12 kHz.
    c. The loudspeakers shall be suitable for recess mounting in a standard 4-inch recessed mounted loudspeaker round enclosures provided under another contract.
    d. A white, 22 gauge steel loudspeaker grille shall be provided.

2. These loudspeakers shall be surface mounted in non-public areas of the Airport buildings which do not have ceilings.
3. Manufacturer:

    a. Atlas FC104T72 with Aluminum Housing 410-4 and support mounting hardware.
    b. or approved equal.

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K. Type S10, Full-range Paging Loudspeaker, Surface Mount:

1. Loudspeaker Type S10 shall be a full-range device with a frequency response of ±3 dB, 80 Hz to 20 kHz and input sensitivity of 90 db at 1 meter with 1 watt input at 500 Hz to 2500 Hz.

    a. The coverage shall be nominal 100 degrees horizontal from 500 Hz to 2.5 kHz.
    b. The power rating shall be 100 W minimum, and a 70 volt line matching transformer with 7.5, 15 and 30 watt taps and a maximum insertion loss of 0.5 dB from 100 Hz to 15 kHz shall be provided.
    c. The loudspeaker shall be surface mounted and enclosed in a UL 94V-0 rated injection molded or metal enclosure with integral metal grille and mounting bracket to allow aiming.
    d. A cover plate for a 4- inch square electrical box shall be provided with grommeted wire access hole.

2. These loudspeakers shall be utilized in the public areas of the Concourses, and shall be surface mounted on the sides of crossover bridges and walkways.
3. Manufacturer:

    a. Atlas SM52TB.
    b. or approved equal.

L. Type S11, Full-range Paging Loudspeaker, Pendant Hung:

1. Loudspeaker Type S11 shall be a white 8- inch diameter coaxial device with a minimum input sensitivity of 90 dB minimum measured at 1 meter with 1 watt input from 500 Hz to 2.5 kHz, frequency response shall be ± 5 dB, 60 Hz to 20 kHz and the coverage angle shall be a nominal 100 degrees conical from 500 Hz to 2.5 kHz.

    a. The loudspeakers shall be rated for 60 W minimum, and a 70 Volt line matching transformer with 0.5 dB maximum insertion loss over the frequency range of 100 Hz to 15 kHz and selectable level taps at 1.9, 3.8, 7.5, 15, 30 and 60 watts shall be wired in parallel with the voice coil.
    b. Type S11 loudspeakers shall be suitable for mounting in a 8- inch suspended round pendant enclosure.
    c. Suspension hangers shall be provided to lower loudspeaker within 15 ft. of the floor.

2. These loudspeakers shall be mounted to down pipe suspended from structure above with safety cable concealed in the down pipe in the ceiling of public areas of the Concourses where ceiling heights exceed 20 ft.
3. Manufacturer:

    a. Atlas PM8FA-W.
    b. or approved equal.

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2.12 OTHER DEVICES

A. Equipment Racks:

1. Vertical floor equipment racks shall be located in P.A. Rooms and shall be constructed of heavy gauge steel frame with removable sides and rear door.

    a. Racks shall be equipped with 11 gage CRS adjustable mounting rails plated, drilled and tapped 10-32 thread on E.I.A. standard hole spacing, and shall accept standard 19" rack-mountable equipment.
    b. Cabinet depth shall be 25-1/2" and provide 77-1/8" rack space mounting.
    c. Racks shall allow opening on sides and bottom to facilitate wiring of components, shall have a rear door equipped with a cylinder lock and shall have louvered top and side panels.
    d. Base shall be tapped to accept leg levelers, and the frame shall be finished in textured black.
    e. The top and side panels, rear door, and all trim shall be finished as directed by the DEN Project Manager.

2. Except as otherwise specified or shown, ECS equipment shall be installed in equipment racks. Include racks for facilities for which racks are not shown on the drawings, and provide an adequate number of sections, at all locations, for installation of the equipment, which the Contractor will provide.

B. Sound System Terminal Cabinets:

1. Wall mounted terminal cabinets shall be provided in each P.A. Room and ECS Control Room to allow breakout of wiring from conduit to the equipment racks.

    a. The terminal cabinets shall be 36"H by 24"W by 9"D and constructed of 14 gauge CRS throughout.
    b. Rear section shall be of one-piece construction with all welded seams.
    c. Cabinet finish shall be as selected by DEN Project Manager from standards available.
    d. Cabinet shall include AMP Flexiblocks with track and end stops for cable termination and connection points.

2. Manufacturer:

    a. Hoffman T series cabinet.
    b. or approved equal.

3. Tenant ECS terminal boxes shall provide loudspeaker connection points and be a minimum 12”x12”x6”.

    a. Provide Amp flex terminal strips or other approved method of connection that is field serviceable for testing and troubleshooting in the terminal box for loudspeaker connections.

C. Wiring and Conductors:

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1. Microphone and Line Level Cable:

    a. Microphone, line level, and ambient sensor cable, when installed in conduit, shall be NEC Type CM cable consisting of ASTM stranded tinned copper, 22 AWG, 100% aluminum polyester foil shielded twisted pair with tinned copper drain wire and 75 degree Centigrade rated polypropylene insulation.

        1) The cable shall have a nominal O.D. of 0.135" with a green outer jacket, nominal capacitance of 34 pF/ft. between conductors and nominal capacitance of 67 pF/ft. between one conductor and other conductors connected to shield.

    b. Where cable is installed in cable trays, it shall be NEC Type PLTC stranded tinned copper, 22 AWG, 100% aluminum polyester foil shielded twisted pair with tinned copper drain wire.

        1) The insulation shall be PVC with nylon and rated for 105 degrees Centigrade.
        2) The cable shall have a nominal O.D. of 0.201" with a green outer jacket, a nominal capacitance of 50 pF/ft. conductor to conductor and a nominal capacitance of 90 pF/ft. between one conductor and the others connected to the shield.

    c. Manufacturer:

        1) West Penn Wire – 25291BGN1000
        2) or approved equal.

2. Trunk loudspeaker cable:

    a. Manufacturer: Smartwire, #001260-11BR or Equal.
    b. Size: #12 AWG, stranded.
    c. Type: Unshielded twisted pair.
    d. Insulation Color: Red (positive), black (negative).
    e. Jacket Color: Dark green.
    f. Cable shall be plenum rated.
    g. All cable shall be installed in conduit.
    h. Loudspeaker circuits shall not contain T-Tap or star configurations.

3. Branch loudspeaker cable:

    a. Manufacturer: West Penn, #25226B or Equal.
    b. Size: #14 AWG, stranded.
    c. Type: Unshielded twisted pair.
    d. Insulation Color: Red (positive), black (negative).
    e. Jacket Color: Dark green.
    f. Cable shall be plenum rated.
    g. All cable shall be installed in conduit.
    h. Loudspeaker circuits shall not contain T-Tap or star configurations.

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4. Control cable shall be installed in conduit and shall be low capacitance 22 AWG stranded four twisted pair with 100% aluminum polyester overall shield and drain wire.

    a. The nominal O.D. shall be 0.325" with a green outer jacket, nominal conductor D.C.R. shall be 24 ohm/1000 ft., the nominal capacitance shall be 15.5 pF/ft. between conductors and the nominal capacitance shall be 27.5 pF/ft. between one conductor and other conductors connected to shield.

5. The installation may involve localized conditions in which metallic-conductor cable systems will transition from conduit to tray installation, and vice versa, for limited lengths of run.

    a. If a cable is transitioning from a room via tray into conduit for the remaining distance of the run, the wiring should be the type rated for use in conduit.
    b. If the majority of the cable run is in conduit, use cable rated for such use.
    c. If the majority of the cable run is in cable tray, use cable rated for use in tray.

2.13 RACEWAYS

A. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Section 260533 "Raceway and Boxes for Electrical Systems."

B. All cabling shall be housed in factory-painted green conduit raceway.

C. Where existing conduit is permitted to be reused based on other sections, conduits shall be brought into compliance with current NEC requirements and shall be banded green and labeled “ECS” every 5 feet where accessible.

D. Provide a complete raceway system for the ECS. Emergency signal infrastructure from Master Microphone stations or network connections for amplifier frames shall not be allowed in cable trays. They must be provided in conduit. Raceways shall be installed utilizing the most efficient route.

E. Outlet boxes shall be not less than 2- inches (50 mm) wide, 3- inches (75 mm) high, and 2-1/2- inches (64 mm) deep.

F. Flexible metal conduit is allowed where other conduit will not suffice.

2.14 MISCELLANEOUS

A. Cable Labels:

1. Self-adhesive, pre-printed labels with black text on white background, as produced by Brady BMP21 or equal.

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B. Loudspeaker Labels:

1. Self-adhesive, pre-printed 1” x 0.5” labels with red text on white background, printed with the following text: “FIRE ALARM DO NOT DISCONNECT”

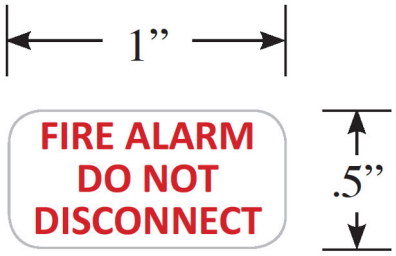


Figure 1 - Sample Loudspeaker Label

PART 3 - EXECUTION

3.1 GENERAL

A. All work shall be provided complete, and the ECS shall be fully operational as shown and described herein.

B. Modifications and additions to the existing ECS:

1. Work Meeting:

a. The Contractor shall coordinate and arrange a pre-work meeting with the DEN Project Manager and DEN Life Safety one week in advance of the beginning of any work.
b. The Contractor shall assure attendance of trades installing the ECS including any electrical, telecommunications, and audio-related trades involved.
c. The Contractor shall present the contractor’s construction, demolition, phasing, implementation, and testing plans and schedule.
d. Meeting notes shall be accurately recorded by the DEN Project Manager and distributed within three (3) working days.

2. All Work shall be provided complete, and the voice paging systems shall be fully operational as shown and described herein. DEN Life Safety shall witness all final connections to existing circuits.
3. Modifications and additions to the existing ECS:

a. Contractors must give DEN AIM five (5) working days’ notice before making any connections, deletions, or modifications to the existing sound system.
b. DEN System Shutdown Request form must be used for this purpose.

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C. Electrical Related Work:

1. Furnish and install all electrical conduit, wiring, and outlets for electrical power to paging and announcement control equipment.
2. Furnish and install raceway, conduit, junction boxes and for audio signal and control wiring.
3. Furnish and install loudspeaker junction boxes and enclosures.
4. Furnish and install ground conductor from building earth ground to each group of equipment racks in accordance with requirements of Section 260526 "Grounding and Bonding for Electrical Systems". The insulated ground conductor shall be installed in conduit and sized for a DC resistance of 0.1 ohm or less to ground. For example, a 15 ft. run would be 8 AWG or larger.

D. Power or ECS System Outages:

1. Any power or ECS System outages necessary to demolish, install or test systems and/or equipment shall be coordinated with Denver International Airport Project Manager.
2. A written shutdown request form shall be submitted to and approved by the DEN Project Manager five (5) working days prior to the shutdown.

3.2 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site and store and protect under provisions of Division 01.

B. Store products in secure locations as approved and directed by DEN Project Manager.

3.3 FABRICATION

A. Designation/Engraving:

1. All equipment controls, receptacles, and all indicators shall have, unless otherwise noted, permanently engraved or silk-screened, fully descriptive identification labels. The resolution of silk-screened labels shall not be less than 90,000 dots/sq. in.

B. Terminals and Terminations:

1. Cables shall not be spliced or otherwise interrupted from termination to termination.

    a. All cables shall have visible heat-shrink identifying markers on each end in compliance with DEN labeling standards.

2. Wiring in terminal cabinets shall be tied and clamped neatly to backboards or cable forms.
3. Terminal blocks shall be fully insulated, rated for the wire size to be terminated, suitable for mounting inside an electrical enclosure and, unless otherwise

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specified, be one of the following types:

a. Terminal strips with interposing barriers between screw terminals.
b. Terminal strips with gas-tight screw type clamp connectors.

4. Each terminal strip shall have a legibly marked permanent identification strip.

C. Structural Assemblies:

1. Loudspeaker mounting frames and brackets shall be fabricated and assembled in shop to the greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings.
2. Provide high-strength threaded fasteners for bolted connections and comply with AWS code for procedures, appearance, and quality of welds and for methods used in correcting welding work.
3. Provide holes required for securing other components or assemblies to structural steel framing and for passage of other components through steel framing members as shown on final shop drawings. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning.
4. In fabricating mounting brackets and other steel components requiring bends, the radii of the bends shall not be less than three times the thickness of the steel being bent.

3.4 REDUNDANCY

A. The PA System shall be a fully redundant system with the minimum basic requirements of the following:

1. Redundant Globalcom equipment shall be implemented into the system for full redundancy.

a. Locate redundant Lifeline Globalcom as shown on contract documents.

B. System shall be connected via a physically separated fiber optic premise wiring system designed for the Fire Alarm System.

1. Redundancy shall include redundant core and intermediate switches with redundant connections to the edge switch as shown on contract drawings.

C. IP Microphone stations shall connect to each regional Announcement Control System (ACS) over Owner provided network.

1. The remainder of the ECS equipment Ethernet connectivity shall be provided by a stand-alone Ethernet network consisting of access layer switches, pairs of regional distribution switches and core switches.
2. Connectivity of access layer to distribution switches shall be done using diversely routed fire alarm system single mode fiber provided by Owner.
3. Inter-Building connectivity shall use DEN Premise Wiring and Distribution System Fiber Strands.

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D. Cabling required for network infrastructure shall be provided by the Owners Premise Wiring Contractor Services (PWCS).

1. PWCS shall be provided with the drawings and shall then provide pricing to be included in the Project for the network cabling and connectivity.

3.5 INTERFACES

A. Several interfaces to other system shall be required for both physical hardware and software. These systems include, but are not limited to Fire Alarm System, AIDX Database, Tenant PA systems, and DEN Networks. Specific requirements for each shall be as follows:

1. Fire Alarm System Interfaces shall be connected to ACS and Globalcom locations throughout the airport.

a. Provide interfaces through dry contacts to allow required functionality to occur including tenant areas.
b. System sequence of operation shall be defined by Section 283100 "Intelligent Life Safety Fire Management System" and Section 283112 and the fire alarm documentation.
c. Critical faults from the ECS shall be faulted to the fire alarm system through the interface.

2. Airport Information Data Exchange (AIDX) Database shall provide information for the Flight Announcement System. System shall be interfaced at IED Server locations.
3. DEN Networks:

a. DEN networks work and interfaces shall be coordinated at the Pre-construction meeting.
b. DEN network representatives shall be available during any scheduled work with regard to interfaces or LAN, VLAN modifications of the PA system.

3.6 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

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3.7 INSTALLATION OF RACEWAYS

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.8 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Separation of Wires:

1. Separate microphone, line-level, loudspeaker-level, and power wiring runs.
2. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for loudspeaker microphones and adjacent parallel power and telephone wiring.
3. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.9 INSTALLATION

A. Identification of Conductors and Cables:

1. Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
2. Clearly, logically and permanently mark switches, connectors, jacks, relays, and receptacles.

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B. Weatherproof Equipment:

1. For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

C. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

E. Mount equipment firmly in place, including loudspeakers, amplifiers, and cables in accordance with manufacturer’s instructions. Make fastenings and supports adequate to support their loads with a safety factor of three. Appliances shall be mounted independently of their attachments to the circuit conductors.

F. Appliances subject to mechanical damage shall be suitably protected. If guards, covers, or lenses are employed, they shall be listed for use with the appliance.

G. Secure equipment firmly in place, including loudspeakers, amplifiers, and cables. Make fastenings and supports adequate to support their loads with a safety factor of three

H. Clearly, logically and permanently mark switches, connectors, jacks, relays, receptacles, junction boxes, loudspeakers, cables, and cable terminations.

I. The Contractor shall take precautions to prevent electromagnetic and electrostatic hum. Install the equipment to provide safe operation. Provide ventilation as required to maintain equipment within the manufacturer's specified temperature limits.

J. Provide all cables necessary for interconnection of permanently mounted equipment. Use terminations required to achieve full function of equipment as specified herein.

K. Exercise care in wiring, to avoid damage to the cables and to the equipment. Make all joints and connections with rosin-core solder or with mechanical connectors approved for Class I wiring. Execute all wiring in strict adherence to standard broadcast procedures.

L. Run lines in separate metallic conduits or install cable tray dividers for microphone level circuits (up to -20 dBm), line level circuits (up to +30 dBm), loudspeaker circuits (above +30 dBm) and power circuits. Ground power conduits with heavy wire to the power system ground. Use only cables which are insulated from the conduit and from each other for the entire conduit length. Connect conduits mechanically and electrically to the sound system ground point. Do not splice lines in conduit.

M. The Installer shall coordinate all sound equipment panel and control locations with the DEN Project Manager prior to installation.

N. Speaker circuits shall be run in continuous line to provide circuit supervision utilizing End of Line Module.

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O. Speaker circuits, loudspeakers, and control equipment shall be installed to meet the pathway survivability requirements of NFPA 72, Chapter 24. Specifically, Level 1 Pathway Survivability shall be provided.

3.10 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Section 260526 "Grounding and Bonding for Electrical Systems."

3.11 SYSTEM PROGRAMMING

A. Programming:

1. Fully brief Owner on available programming options.
2. Record Owner's decisions and set up initial system program.
3. Provide all programming required for a fully functioning system and associated interfaces.
4. Prepare a written record of decisions, implementation methodology, and final results.

3.12 TESTING AND CERTIFICATION

A. Electrical/Electronic Tests and Inspections: At the job site, the Contractor shall perform tests not conducted and certified by the manufacturer and, be prepared to repeat any or all tests as may be directed by the DEN Project Manager during the period of final inspection and checkout. Furthermore, the Contractor shall be prepared to perform work required to modify the performance of the system in accordance with this specification. Test all electrical circuits before plugging ECS equipment into the circuit.

1. Schedule tests with DEN Project Manager with at least seven (7) days' advance notice of test performance. Do not proceed with testing without written approval from DEN Project Manager.
2. General Inspection and Adjustment: Make all measurements, and subsequently deliver documentation, to demonstrate that all individual components, not previously measured and certified by the manufacturer, are performing in accordance with each manufacturer's published specifications. Specifically, examine frequency response, total harmonic distortion, and signal-to-noise ratio. Replace any components found to be defective.
3. Operational Test: Test microphone stations at each area that the microphone station is installed. Verify proper routing and volume levels and that system is

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free of noise and distortion. Test each available message path from each station on system.

4. Redundancy Test: Test redundancy and back up amplifier switching for all redundant components including a power loss scenario. Determine that system components are configured for automatic boot up recovery as part of redundancy and that the appropriate files are correctly backed up for system configurations.
5. Distortion Test: If distorted signal is present, measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into selected amplifiers. For each frequency, measure distortion in the system outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics. Replace defective equipment
6. Acoustic Coverage Test: Feed pink noise into system. Use sound-level RTA meter with octave-band filters to measure level at three locations in each paging zone. Equalize and delay loudspeakers with Pink Noise and sufficient analyzer to maximize audio quality and intelligibility in every instance. Consultant shall spot check these loudspeaker systems with the Contractor in the field during test out. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB. Set equalization for maximum flat response of loudspeaker system. Use filters to cut, if possible, rather than boost frequencies. If 6dB of boost or cut is required, verify position of test microphone, loudspeaker polarity issues, or reflections that may be skewing the test. Slight repositioning of the test Microphone may be required
7. Power Output Test: If loudspeaker performance is not producing the required and calculated level in a zone, measure electrical power output of each paging amplifier at normal gain settings of 150, 1000, and 2500 Hz. Maximum variation in power output at these frequencies is plus or minus 3 dB. Replace defective equipment or verify loudspeakers are tapped and performing correctly.
8. Signal Ground Test: Measure and report ground resistance at system signal ground. Comply with testing requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
9. Loudspeaker Line Impedance: Measure the impedance and the resistance of each loudspeaker line leaving the sound equipment racks with the line disconnected from its normal driving source. Maintain values within ± 10% of the value calculated for that circuit based upon the parallel impedances of the loudspeakers connected plus the resistance of the loudspeakers. Measure loudspeaker impedance at multiple frequencies according to the loudspeaker type. Measure for ground faults on each leg of the loudspeaker system. Correct any faults found for both impedance and ground faults. Loudspeaker circuits shall not be loaded greater than 80% of listed amplifier capacity.
10. Hum and Noise Level: If hum or noise is present, measure the hum and noise levels of the overall system. Adjust gain controls for optimum signal-to-noise ratio. The adjustment shall also be such that full amplifier output would be achieved with O dBm input. Terminate inputs with shielded resistors of 600 ohms, and disconnect the loudspeaker lines, terminating the power amplifier outputs with power resistors for these measurements. The load resistors shall match the rated load impedance and output power of the amplifiers.
11. Power Output and Signal Level Adjustments: Adjust gain controls as for the hum and noise level test. Set variable equalizers for flat response. Apply 1,000 Hz sinewave signal at the input tested, at a level required to produce a full

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amplifier output. Use a distortion analyzer to measure the output level and total harmonic distortion of the amplification equipment. Make all measurements with loads actually incurred in system operation. Power amplifier loads shall be resistors equal to the nominal impedance of the output terminals used in the system.

12. Gain Control Settings: Establish tentative normal settings for all gain controls. All gain controls on rack-mounted equipment shall be adjusted for optimum signal-to-noise ratio and signal balance. Settings may require further adjustment by the Contractor as a result of testing by the DEN Project Manager. Programmed settings shall be recorded in hardcopy format.
13. Provide System Set with no faults. System shall run fault free from the Contractors work for a minimum of 30 days with no issues for final closeout of work.
14. Freedom from Switching Transient Noise: Operate all control switches and relays, while listening for clicks and pops in the system outputs. Eliminate any found.
15. Listening Tests: These tests shall include speech intelligibility surveys and subjective aural evaluations by observers at various positions under various operating conditions, using live speech and/or recorded music material.
16. Equipment Tests: Any measurements of frequency response, distortion, noise, or other characteristics and any operational tests deemed necessary may be performed on any item or group of items to determine conformity with these requirements. Measurements of system performance shall be made using a calibrated ANSI S1.4, Type 1 sound level meter set for "slow" meter damping and flat response. The microphone shall be positioned 5 feet above the floor within the area served by the system. All interior finishes and furnishings shall be in place, and the system gain shall be set to provide octave band levels at least 10 dB above background noise levels in any octave band at the measuring locations.
17. Identification: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging loudspeaker-line matching transformers.

B. Demonstration Test: Upon completion of installation, and at a time established by DEN Life Safety, demonstrate the operation of each major component of the system and the completed installation. Assist as required in the following acceptance tests:

1. Reference Appendix A for checklist items required for the Demonstration Test.
2. Prior to connection to the ECS, DEN Life Safety will test the loudspeaker system for impedance, shorts, and grounds. The contractor shall perform a basic short and ground test of the completed wiring system in advance of this test. Any anomalies noted in either test shall be corrected by the contractor before the loudspeaker(s) will be connected to the ECS.
3. Upon completion of the ECS installation, the contractor shall arrange with DEN Life Safety to review programming and conduct a test of the emergency paging within the tenant or concession area. This test may be scheduled during a period of low airport activity at night at the discretion of DEN Life Safety.
4. This work requires a mandatory shutdown request.
5. Listening Tests: These tests shall include speech intelligibility survey and subjective aural evaluations by observers at various positions under various

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operating conditions, using live speech and/or recorded speech.

6. If the need for adjustment or modification becomes evident during demonstration and testing, accomplish adjustments or alterations until the installation operates fully in accordance with the requirements of this specification.

C. DFD Acceptance Test:

1. Reference Appendix A for checklist items required for the DFD Acceptance Test.
2. Upon satisfactory completion of the demonstration test, DEN Life Safety will schedule DFD Acceptance Test. This notification shall occur a minimum of 5 days prior to the desired time of the test. This test may be scheduled during a period of low airport activity at night at the discretion of DEN Life Safety.
3. This work requires a mandatory shutdown request.

D. The ECS shall be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. Report:

1. Upon completion of the above tests and any necessary adjustments, submit two (2) copies of a written report presenting test results, including numerical values where necessary, for review by the DEN Project Manager prior to acceptance testing, final tuning, and demonstration.
2. With this report, submit written certification that the installation conforms to the requirements stated herein, is complete in all respects, and is ready for inspection, testing and final tuning.

3.13 STARTUP SERVICE

A. Engage an IED factory-authorized service representative to assist Contractor and perform startup service and initial system programming and final commissioning.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

3.14 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within [**twelve (12)**] months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two (2)**] visits to Project during other-than-normal

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occupancy hours for this purpose.

3.15 MAINTENANCE SERVICE

A. Replace defective materials and repair faulty workmanship within 48 hours of discovery during the period of the warranty.

3.16 DEMONSTRATION

A. Engage a factory-authorized service representative to assist Contractor and train Owner's maintenance personnel to adjust, operate, and maintain the intercommunications and program systems.

1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining the system and equipment.
2. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

B. Upon approval of the test report by the DEN Project Manager, and at a time established by the DEN Project Manager, demonstrate the operation of each major component of the system and the completed installation. After demonstration, assist as required in the following acceptance tests:

1. Listening Tests: These tests shall include speech intelligibility survey and subjective aural evaluations by observers at various positions under various operating conditions, using live speech and/or recorded music material.
2. Equipment Tests: Any measurements of frequency response, distortion, noise or other characteristics and any operational tests deemed necessary may be performed on any item or group of items to determine conformity with these requirements.
3. If the need for adjustment or modification becomes evident during demonstration and testing, accomplish adjustments or alterations until the installation operates fully in accordance with the requirement of this specification.

PART 4 - MEASUREMENT

4.1 METHOD OF MEASUREMENT

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

PART 5 - PAYMENT

5.1 PAYMENT

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A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Lump Sum Contract price.

END OF SECTION 275123

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APPENDIX A – EMERGENCY COMMUNICATION SYSTEM (ECS) PRE-INSPECTION CHECKLIST

	Yes	No	Item	Initials
1			Confirm that a shutdown requests is in place prior to working on any part of the emergency communication system.	
2			The Approved set of drawings and permit card are on job site before inspection.	
3			All conduits shall be green or green striped.	
4			Follow the Wire Schedule provided on ECS shop drawings.	
5			All loudspeaker cables shall be labeled with loudspeaker circuit ID at all terminations and junction boxes.	
6			Shop drawings have been submitted.	
7			Where an end of branch monitor is used, the device(s) and their enclosures must be marked ECS EOL.	
8			The "Tie-in" points for the ECS loudspeaker circuits are clearly shown on the shop drawings.	
9			A ground fault test shall be completed before the Tie-in is completed in the presence of a DEN Life Safety representative.	
10			All deficiencies shall be corrected and retest in the presence of DEN Life Safety prior to final inspection.	
11			An impedance test shall be completed before the Tie-in is completed in the presence of a DEN Life Safety representative.	
12			A representative from the installing company with a current CCD Fire Alarm Installers license or CCD Mass Notification System Installers license must be present during final testing	
13			Stamped set of plans and Permit card on hand at time of test.	
14			All required testing materials are available for the test. These include but are not limited to: ladders, extension cords, impedance meter, multimeter, sound pressure level meter	
15			All appropriate parties are present & access to the area being inspected has been arranged. These include: Owner Rep; Licensed contractor, etc.	
16			Spare Parts delivered to DEN Technical Maintenance	

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SECTION 283100 - INTELLIGENT LIFE SAFETY FIRE MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

B. The requirements of construction permits and authorization to proceed shall become part of this specification. Construction permits shall be obtained and paid for by the Contractor unless otherwise indicated by the DEN Project Manager. Prior to commencement and after completion of the Work, the Contractor shall be responsible for securing all permits and scheduling all inspections with the appropriate Authority Having Jurisdiction (AHJ).

1.2 SUMMARY

A. The Contractor shall provide all skilled labor, material, and equipment for the complete installation of the fire detection and alarm system **additions and modifications** as shown on the drawings and specified herein. The Contractor shall coordinate new work **with the existing fire alarm system** and acquire from the manufacturer the installation practices as published by the manufacturer. Installation shall comply with manufacturer published installation guidelines except as noted in these specifications.

B. This specification is provided in support of the tenant finish project as defined herein. The general scope of the project is to provide a fire alarm system that is compliant with these documents and all applicable codes, standards, and project requirements. Upon project completion a complete and fully functional system shall be provided to Denver International Airport (Owner).

C. The Contractor shall be responsible to provide a complete installation and conduct testing in compliance with DEN requirements, Denver Building Codes, and Denver Fire Prevention Bureau requirements. If conflicts occur in this specification or between this specification and the Contract Documents, the most stringent requirement shall apply.

D. The drawings referenced by this specification are for design concepts only, and do not represent installation practices, methods, or means. The Contractor shall provide engineered shop drawings for permitting and construction that reflect details of field installation, and that will become the basis for final installation drawings.

E. The Engineer responsible for the design of the fire alarm and emergency communications system for this project shall be known as the Engineer of Record (EOR). The Engineer shall be responsible for the technical accuracy of drawings.

F. The Contractor shall be responsible for ensuring that all documentation submitted will result in the issuance of the permit to proceed by the AHJ.

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G. Owner's Designated Representative shall be responsible for obtaining concurrence between the appropriate DEN organizations, including Airport Infrastructure Management, in order to formalize Owner approvals.

H. Related Sections:

1. Section 260519 "Low Voltage Electrical Power Conductors and Cables".
2. Section 260526 "Grounding and Bonding for Electrical Systems".
3. Section 260529 "Hangers and Supports for Electrical Systems".
4. Section 260533 "Raceways and Boxes for Electrical Systems".
5. Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling".
6. Section 260553 "Identification for Electrical Systems".
7. Section 262726 "Wiring Devices".
8. Section 275123 "Emergency Communications System".

I. Alternates: Refer to Division 01 Section 012300 "Alternates" for description of Work in this Section affected by Alternates.

1.3 DEFINITIONS AND ABBREVIATIONS

A. AHJ – Authority Having Jurisdiction.

B. ASD – Aspirating Smoke Detection.

C. Contractor – The term Contractor in this Section shall apply to the organization directly responsible for the installation of the complete installation of the fire detection and alarm system.

D. DEN – Denver International Airport.

E. ECS – Emergency Communication System.

F. Engineer – The Engineer is responsible for the design of the fire alarm and emergency communications system for this project and fulfills the design responsibility of the Engineer of Record.

G. FACP – Fire Alarm Control Panel.

H. FCC – Fire Command Center as defined by Denver Amendments to the International Fire Code.

I. FSCS – Firefighter Smoke Control Station [**referred to as a Firefighter Smoke Control Panel (FSCP) in the Denver Amendments**].

J. Manufacturer – The term manufacturer in this Section shall apply to the organization responsible for providing fire alarm equipment, system design, and system programming as defined herein. The manufacturer of the majority of the fire alarm equipment is SimplexGrinnell.

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K. Owner – Denver International Airport (DEN).

L. SLC – Signaling Line Circuit.

M. TSW – TrueSite Workstation.

1.4 REFERENCED 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. A listing of applicable reference standards is contained in Division 1. Adherence to these standards will be strictly enforced.

B. National Fire Protection Association (NFPA):

1. NFPA 3, Recommended Practice for Commissioning and Integrated Testing of Fire Protection and Life Safety Systems.
2. NFPA 13, Standard for the Installation of Sprinkler Systems (2010 Edition).
3. NFPA 20, Installation of Stationary Pumps for Fire Protection (2010 Edition).
4. NFPA 70, National Electrical Code® (2011 Edition).
5. NFPA 72, National Fire Alarm and Signaling Code® (2013 Edition).
6. NFPA 92A, Standard for Smoke-Control Systems Utilizing Barriers and Pressure Differentials (2009 Edition).
7. NFPA 92B, Standard for Smoke Management Systems in Malls, Atria, and Large Spaces (2009 Edition).
8. NFPA 101, Life Safety Code® (2009 Edition).
9. NFPA 130, Standard on Fixed Guideway Transit and Passenger Rail Systems (2007 Edition).
10. NFPA 415, Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways (2008 Edition).

C. 2009 International Building Code (IBC) with the Denver Amendments.

D. 2009 International Fire Code (IFC) with the Denver Amendments.

E. 2009 International Mechanical Code (IMC) with the Denver Amendments.

F. City and County of Denver Building and Fire Code Amendments.

G. Underwriters Laboratories (UL):

1. UL 6, Electrical Rigid Metal Conduit – Steel.
2. UL 38, Standard for Manual Signaling Boxes for Fire Alarm Systems.
3. UL 228, Standard for Door Closers-Holders, With or Without Integral Smoke Detectors.
4. UL 268, Smoke Detectors for Fire Alarm Systems.
5. UL 268A, Standard for Smoke Detectors for Duct Application.
6. UL 464, Standard for Audible Signal Appliances.
7. UL 521, Standard for Heat Detectors for Fire Protective Signaling Systems.
8. UL 797, Electrical Metallic Tubing – Steel.

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9. UL 864, Standard for Control Units and Accessories for Fire Alarm Systems.
10. UL 1242, Standard for Electrical Intermediate Metal Conduit – Steel.
11. UL 1480, Standard for Speakers for Fire Alarm, Emergency, and Commercial and Professional Use.
12. UL 1971, Standard for Signaling Devices for the Hearing Impaired.
13. Other UL Standards shall be applied to ensure that all materials are listed for their intended purpose.

H. United States Access Board (USAB) – Americans with Disabilities Act (ADA) and the 2010 ADA Standards for Accessible Design.

I. American Society of Mechanical Engineers (ASME):

1. ASME A17.1, Safety Code for Elevators and Escalators (2004 Edition; 2005 Supplement).
2. ASME A17.3, Safety Code for Existing Elevators and Escalators (2005 Edition).

1.5 SYSTEM DESCRIPTION

A. Provide the required additions/alternations necessary for a complete, addressable, networked microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices, and other equipment as specified herein. The system shall include, where necessary, fire alarm control panels, workstations, power expansion panels, and all other required components as necessary to ensure compliant operation and interoperability of this system.

B. Systems, equipment, and services to be provided and installed shall include all programming, equipment, devices, raceways, and wiring required to allow the system to operate as a low voltage, fully addressable Fire Management System and shall include, but not be limited to, the following to provide a complete operating system:

1. Fire alarm equipment and devices.
2. Fire alarm system software updates and modifications.
3. Network software modifications to all workstations.
4. Raceways, boxes, fittings, and accessories.
5. Connection to and interface with equipment and devices monitored or controlled by the fire alarm system.
6. Record documents to include plan drawings, panel schedules, and hard copy of system programming.
7. System acceptance testing.

C. UL listing: All provided equipment shall be listed under the appropriate category by Underwriters Laboratories, Inc. (UL) for its intended purpose and shall bear the appropriate UL label. UL shall be the primary listing agency. However, listing from other agencies shall be acceptable when approved by DEN.

D. The system shall be designed with the following spare capacity.

1. Signaling Line Circuits shall have 10% spare capacity.

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2. Notification Appliance Circuits shall have 10% spare capacity except areas with tenants shall have 20% spare capacity.
3. Batteries provided for the new fire alarm system shall be sized for 120% of required capacity, except that NAC Power Extender panel batteries shall not be required to exceed the panels charging capacity.
4. If the above-indicated spare capacity cannot be maintained within the scope of this Work, notification shall be provided to the DEN Project Manager, DEN Life Safety, and SimplexGrinnell for direction on how to proceed with the system modifications.

1.6 SYSTEM OPERATING FEATURES

A. Software:

1. The fire alarm system shall allow for loading and editing instructions and operating sequences. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. The system shall be capable of storing dual configuration programs with one active and one in reserve. The FACPs shall be capable of full system operation during a new configuration download.

B. History Logs:

1. The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.

C. Recording of Events:

1. Provide means to record all alarm, supervisory, and trouble events in system workstations including the type of signal (alarm, supervisory, or trouble) with the device identification, date and time of the occurrence.

D. Maximo Interface:

1. The system shall include an SQL interface at one or more of the fire alarm control panels configured to send text messages of alarm, trouble and supervisory events to DEN’s Maximo system. The Fire Alarm system shall have the capability to accept a .csv file from Maximo and manually download this data into the Simplex Programming File by a Factory Authorized Technician.

E. Network communication:

1. Network node communication shall be via token ring technology. The TSW shall reside as a node on the token ring network unless otherwise configured and approved.
2. A single open on the network communication loop shall not compromise network

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communications. The token shall be passed in the opposite direction to maintain communications throughout all network nodes. At the same time the status of the communication link shall be reported.

3. If a group of nodes becomes isolated from the rest of the network due to multiple fault conditions, that group shall automatically form a sub-network with all common interaction of monitoring and control remaining intact. The network shall be notified with the exact details of the lost communications.
4. Fiber optics communication shall be provided via a fiber optics modem. The modem shall multiplex audio signals and digital communication via full duplex transmission over a single fiber optic cable.
5. If adding an FACP or TSW, the Contractor shall be responsible for fiber connection at the DEN provided fiber optic patch panel at each location. The Contractor shall be responsible for fiber connection at the fire alarm control panel or the fire alarm system workstation.

F. The following are basic required system functions and operating features:

1. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority, respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
2. Noninterfering: An event on one zone shall not prevent the receipt of signals from any other zone. All zones shall be manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device shall not prevent the receipt of signals from subsequent addressable device activations.

G. Transmission to an approved Supervising Station: The existing system is currently configured to automatically route alarm, supervisory, and trouble signals to the Denver Fire Department via an AES subscriber model 7788F on DFD frequency 460.325 MHZ (options: color is RED with 8 E.O.L. inputs). Contractor is responsible for ensuring that all inputs added to the fire alarm system properly report to the Denver Fire Department through the AES transceivers.

H. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP, the Network Display Units, each TSW, and the Airport Fire Department (via TrueSite Client workstations), indicating the type of device, the operational state of the device (i.e., alarm, trouble or supervisory), and the custom label associated with the device.

I. System Reset:

1. The "System Reset" button shall be used to return the system to its normal state. This function shall be available from the TWSs.
2. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur.
3. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-alarming the system. The display message

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shall indicate, "ALARM PRESENT, SYSTEM RESET ABORTED."

4. If the alarm condition remains, the system shall remain in an alarmed condition.
5. The system shall be configured such that either individual or global resets can be accomplished from any TSW.
6. Reset on a fire alarm control panel shall only affect the associated building (i.e., panel reset shall not be complex-wide).

J. Evacuation Drill: A manual evacuation (drill) switch shall be provided to operate the notification appliances at each FACP without causing other control circuits to be activated. The manual evacuation switch shall initiate audible evacuation messages through the associated building ECS system and initiate appropriate visual notification appliances throughout the building.

K. Walk test: The system shall have the capacity of 8 programmable pass code-protected one person testing groups, such that only a portion of the system need be disabled during testing (i.e., no more than one building).

L. Bypass Switches: The workstations and FACPs are provided with bypass functions to allow individual deactivation of fire safety functions. All devices added by this scope of Work must be included in bypass functions as necessary. Bypass switches/controls shall be provided for all appropriate functions including the following:

1. City circuit disconnect.
2. Smoke control activation.
3. Fan shutdown function.
4. Elevator recall and shunt trip.
5. Fire suppression release (where appropriate).
6. Audible and visual notification.

M. Audible Alarm Notification:

1. Notification from the fire alarm system shall be provided directly through visual signaling devices (strobes) connected directly to the fire alarm system, and via audio announcements and textual messaging activated by the fire alarm system and delivered through the IED ECS.

N. Tenant Sound Systems: Provide control modules in each tenant space to disable audible and visual non-emergency systems. Audible and visual systems are to be disabled prior to any ECS announcement in tenant spaces where this functionality has been designed into the system.

O. Fire Suppression Systems Monitoring and Control:

1. Sprinkler Water flow: Activation of a water flow switch shall initiate alarm operations.
2. Sprinkler Valve Tamper Switch: The activation of any valve tamper switch shall activate system supervisory operations.
3. Dry Pipe/Preaction Sprinkler Low Air Signal: The receipt of a low air signal on a sprinkler system shall activate system supervisory operations and clearly indicate the location of the mechanical equipment at the annunciation locations defined

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above.

4. Pre-Action Fire Suppression Systems: Upon activation of alarm initiation devices within an area protected by a pre-action fire suppression system, the suppression releasing sequence shall be initiated unless an abort station has been activated and held. The emergency response station TWSs shall have the ability to manually release the system. Programming of system release from the TSWs shall be on a case-by-case basis at the direction of DEN personnel.
5. Special Suppression Systems: Non-water based suppression and deluge systems are provided with separate Suppression Releasing Panels that monitor initiating devices and initiate suppression system release. The main fire alarm system shall monitor these Releasing Panels for alarm, trouble, and supervisory conditions.

P. Elevator Detection, Controls, and Interfaces:

1. Elevator controls shall be provided in accordance with City and County of Denver Building Permit Policy IBC 903.2.
2. Elevator recall functions: Where elevator recall is required, the following sequences shall be followed. Primary and alternate floors for each elevator or elevator bank shall be as determined for each lobby by the Engineer, DEN Project Manager, and Denver Fire Department.

    a. Primary Floor Recall: Activation of initiating devices, as identified in subsequent paragraphs, cause the elevator to travel to the primary floor, open the elevator doors and remain at that location.

        1) For the Airport Office Building, the elevator doors shall close 60 seconds after arrival at the primary floor.

    b. Alternate Floor Recall: Activation of elevator lobby smoke detector(s) on the primary floor shall cause the elevator to travel to the alternate floor, open the elevator doors and remain at that location.

        1) For the Airport Office Building, the elevator doors shall close 60 seconds after arrival at the alternate floor.

3. Elevator power shunt functions: Where shunting of elevator power is required, provide necessary equipment to cause power shunt functions and to monitor power to the shunt trip circuit. Control and monitor modules necessary to achieve these shunt functions shall be located within 3 feet of the circuit.
4. Smoke Detectors in Elevator Lobbies: Smoke detectors shall be provided in all elevator lobbies within 21 feet of the centerline of each elevator door. Elevator lobbies with ceiling heights greater than 15 feet shall be provided with a sidewall-type smoke detector mounted within 5 feet of the top of the elevator door or as recognized by applicable codes.

    a. Floors Other Than Primary Floor: Activation of elevator lobby smoke detectors on floors other than the primary floor shall cause recall to the Primary Floor.
    b. Primary Floor: Activation of elevator lobby smoke detector(s) on the primary

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floor shall cause recall to the Alternate Floor.

c. Elevator Lobby Doors: If elevator lobby doors with electronic hold-open devices (e.g., magnetic door holders) are provided, activation of lobby smoke detector(s) shall cause release of the doors.

5. Smoke Detectors in Elevator Equipment/Control Rooms: Smoke detector(s) shall be provided in elevator equipment/control rooms that are provided with automatic sprinklers.

   a. Elevator Equipment/Control Rooms on Floors Other Than Primary Floor: Activation of smoke detector(s) shall cause recall to the Primary Floor. Activation of smoke detectors shall also cause activation of the visual alarm (i.e., “flashing hat”) inside the elevator car.
   b. Elevator Equipment/Control Rooms on Primary Floor: Activation of smoke detector(s) shall cause recall to the Alternate Floor. Activation of smoke detectors shall also cause activation of the visual alarm (i.e., “flashing hat”) inside the elevator car.
   c. Where an elevator equipment/control room serves multiple hoistways, sufficient control and monitor equipment shall be provided to complete the identified functions in the effected hoistway only.

6. Heat Detectors in Elevator Equipment/Control Rooms: Heat detectors shall be provided in elevator equipment/control rooms that are provided with automatic sprinklers. Heat detector(s) shall be spaced such that a detector is within 2 feet of all automatic sprinklers.

   a. Elevator Equipment/Control Rooms on Floors Other Than Primary Floor: Activation of heat detector(s) shall cause recall to the Primary Floor followed by shunting of power to the elevator. Sufficient time delay prior to shunt trip to allow for recall from the most remote floor to occur. Activation of heat detectors shall also cause activation of the visual alarm (i.e., “flashing hat”) inside the elevator car.
   b. Elevator Equipment/Control Rooms on Primary Floor: Activation of heat detector(s) shall cause recall to the Alternate Floor followed by shunting of power to the elevator. Sufficient time delay prior to shunt trip to allow for recall from the most remote floor to occur. Activation of heat detectors shall also cause activation of the visual alarm (i.e., “flashing hat”) inside the elevator car.

7. Smoke Detectors in Elevator Hoistways: Smoke detector(s) shall be provided in elevator hoistways where automatic sprinklers are provided.

   a. Top of Hoistway:

      1) Primary Floor is the same as Highest Level of Elevator Access:

         a) Activation of smoke detector(s) shall cause recall to a floor other than the highest level, as defined by the Engineer, DEN Project Manager, and Denver Fire Department. Elevator operation shall be to the Alternate Floor. Activation of smoke

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detectors shall also cause activation of the visual alarm (i.e., “flashing hat”) inside the elevator car.

2) Primary Floor is Other than Highest Level of Elevator Access:

a) Activation of smoke detector(s) shall cause recall to the Primary Floor. Activation of smoke detectors shall also cause activation of the visual alarm (i.e., “flashing hat”) inside the elevator car.

8. Heat Detectors in Elevator Hoistways: Heat detectors shall be provided at the top of elevator hoistways that are provided with automatic sprinklers. Heat detector(s) shall be of the fixed temperature type, with an operating temperature lower than that of the sprinklers (e.g., 190°F heat detector with 286°F sprinklers). Heat detector(s) shall be spaced such that a detector is within 2 feet of all automatic sprinklers.

a. Top of Hoistway:

1) Primary Floor is the same as Highest Level of Elevator Access:

b. Activation of heat detector(s) shall cause recall to a floor other than the highest level, as defined by the Engineer, DEN Project Manager and Denver Fire Department, followed by shunting of power to the elevator. Elevator operation shall be to the alternate floor. Sufficient time delay prior to shunt trip to allow for recall from the most remote floor to occur. Activation of heat detectors shall also cause activation of the visual alarm (i.e., “flashing hat”) inside the elevator car.

1) Primary Floor is Other than Highest Level of Elevator Access:

a) Activation of heat detector(s) shall cause recall to the Primary Floor, followed by shunting of power to the elevator. Sufficient time delay prior to shunt trip to allow for recall from the most remote floor to occur. Activation of heat detectors shall also cause activation of the visual alarm (i.e., “flashing hat”) inside the elevator car.

c. Bottom of Hoistway: Activation of heat detector(s) shall cause recall to a floor other than the lowest level, as defined by the Engineer, DEN Project Manager, and Denver Fire Department, followed by shunting of power to the elevator. Elevator operation shall be to the Alternate Floor. Sufficient time delay prior to shunt trip to allow for recall from the most remote floor to occur. Activation of heat detectors shall also cause activation of the visual alarm (i.e., “flashing hat”) inside the elevator car.

9. Elevator Hoistway Vents: Smoke detector(s) shall be provided in elevator hoistways where vents are provided. Activation of any smoke detector shall cause opening of the vent. Control modules necessary to cause opening of the vent shall be located within 3 feet of the point of connection to the vent controller.

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Q. Power Requirements

1. The control units shall receive AC power via a dedicated, secured circuit breaker. All circuit breakers shall be labeled and secured with a circuit breaker lock.
2. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
3. The incoming power to the system shall be supervised so that any power failure shall be indicated at the control unit. A green "power on" LED shall be displayed continuously at the user interface while incoming power is present.
4. The system batteries shall be supervised so that a low battery or a depleted battery condition, or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
5. The system shall support a NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs to make use of battery reserve for front panel annunciation and control.
6. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
7. Loss of primary power shall sound a trouble signal at the FACP and TSW. The FACP shall indicate when the system is operating on an alternate power supply.

R. Smoke Control System:

1. The system shall provide automatic operation of smoke exhaust fans, makeup air fans, air handling units, and dampers in accordance with the smoke control sequence provided with the drawings. Manual control of the smoke control system shall be provided at each of the TSWs.
2. At no time shall automatic and manual smoke control functions be disabled without receiving written approval from the DEN Project Manager and the Fire Department, at which time a backup plan shall be agreed upon for the duration of the conversion process within a given smoke compartment.
3. Provide addressable control point modules interfaced with the mechanical systems. This includes individual motor starter control modules, “high level” interface points to the building automation systems, damper position indicator monitor modules, and all other system interfaces currently controlled by the existing fire alarm system.

1.7 SEQUENCE OF OPERATION

A. Sequence of operation for HVAC, smoke control, suppression systems, and other interfaced systems shall be indicated on the Contract Drawings.

B. Sequence of operation for security interfaces shall be provided in a Security Sensitive Information (SSI) format acceptable to the DEN Project Manager.

C. Emergency Communication System: The fire alarm system shall interface with the existing ECS for audible notification and for textual visual notification.

D. Presignal Function: Occupant notification shall be provided consistent with presignal

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function from NFPA 72 in Airport Terminal Buildings (i.e., Main Terminal, Concourse A, Concourse B, and Concourse C) as defined by NFPA 72-2013 section 23.8.1.2. Specifics of system operations shall be identified in the design drawings and in project shop drawings.

E. Alarm Conditions: Upon activation of an alarm device, the system shall operate as follows:

1. Indication of alarm condition at the FACP annunciation locations as defined above.
2. Identification of the device that is the source of the alarm at the FACP annunciation locations as defined above.
3. Record the event in the FACP historical log.
4. Operation of audible and visible notification appliances until silenced at Fire Command Centers in non-presignal buildings.
5. Close doors normally held open by magnetic door holders within the affected and adjacent smoke compartments.
6. Initiation of elevator Phase I functions (recall, shunt trip, illumination of indicator in cab, etc.) in accordance with ASME/ANSI A17.1, when specified detectors or sensors are activated, as required by the Denver Fire Department.
7. Initiation of Fire Suppression Sequence in areas protected with special Fire Suppression Systems.
8. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible and visual alarm signals shall cease operation. This function shall be available from the TSWs.

F. Supervisory Conditions: Upon activation of a supervisory device, the system shall operate as follows:

1. Activate the system supervisory service audible signal and illuminate the LED at the control unit.
2. Pressing the Supervisory Acknowledge Key shall silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating an off-normal condition.
3. Record the event in the FACP historical log.
4. Transmission of a supervisory signal to the Denver Fire Department.
5. Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.

G. Trouble Conditions: Upon activation of a trouble condition, the system shall operate as follows:

1. Activate the system trouble service audible signal and illuminate the LED at the control unit.
2. Pressing the Trouble Acknowledge Key shall silence the supervisory audible signal while maintaining the Trouble LED "on" indicating an off-normal condition.
3. Record the event in the FACP historical log.
4. Transmission of a trouble signal to the Denver Fire Department.
5. Restoring the condition shall cause the Trouble LED to clear and restore the system to normal.

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1.8 INTERFACE WITH OTHER SYSTEMS

A. Security: Contractor shall coordinate, provide, and assure complete connection and interface with security systems modified and installed as part of this Contract. Security interface details shall be addressed in separate documents in a Security Sensitive Information (SSI) format acceptable to the DEN Project Manager.

B. HVAC: Contractor shall coordinate, provide, and assure complete connection and interface with HVAC systems modified and installed as part of this Contract.

C. Fire Protection: Contractor shall coordinate, provide, and assure complete connection and interface with Fire Protection system devices.

1.9 ACTION SUBMITTALS

A. Provide submittals in accordance with the provisions of Division 01, General Requirements of the Technical Specifications and as required by this Section.

B. Provide the following submittal information.

1. Manufacturer’s literature describing all products and materials that will be used in the system.

    a. Product data sheets for system components shall be highlighted to indicate the specific products, features, or functions that will be installed as required to meet this specification. These shall be submitted both in a 3-ring binder, as well as electronically submitted in format as required per Division 1 requirements.
    b. Wiring diagrams and installation instructions for individual Fire Alarm Devices prepared by SimplexGrinnell engineering.
    c. Include data substantiating that materials comply with requirements.

2. Shop drawings shall be provided per this Section.

C. Submit NICET certifications for all shop and field installers\programmers as required by this Section with the shop drawing submittal. A copy of all certifications shall be maintained on the project site.

D. Submission to the DEN Project Manager and AHJ:

1. All submittals shall be reviewed by the contractor prior to submission for permit.
2. All submittals shall be reviewed and accepted by the DEN Project Manager prior to submission for permit.
3. Owner’s review shall include DEN Engineering and DEN maintenance/Life Safety prior to submission for permit.
4. Upon receipt of comments from the AHJ, make resubmissions, if required, to make clarifications or revisions to obtain approval and permit.
5. Approved submittals shall remain on the site at all times.

E. Engineered Shop Drawings:

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1. Shop Drawing format:

    a. All drawings shall be scalable at 1/8 inch per foot for full size drawings. Full size drawings shall be plotted on 34 x 44 paper.
    b. When requested, half-size drawings shall be scalable at 1/16 inch per foot and shall be plotted on 17 x 22-inch paper. All drawing information shall be readable when plotted to half-size.
    c. All shop drawings to be submitted electronically in format in compliance with Division 1 requirements.

2. Field Verification:

    a. Field Verification: The Contractor and SimplexGrinnell shall field investigate and assure that system modifications or additions include any modifications required to system capacity.
    b. Room Names and Numbers: Official room names and numbers shall be obtained from the DEN BIM Department for inclusion on shop drawings and fire alarm computer graphic (TSW) workstations. Room names and numbers shall conform to DEN standards through the Autodesk Revit model as maintained by the DEN BIM Department.

3. Shop drawings:

    a. Shop drawings shall conform to all requirements of NFPA, the Denver Department of Fire, and Denver International Airport standards.
    b. Shop drawings shall include but not be limited to all device types and detailing, battery calculations, voltage drop calculations, wiring diagrams, riser diagrams, plans and device addresses.
    c. A riser diagram of the complete fire alarm system.
    d. A complete point-to-point fire alarm system control equipment installation diagram; typical wiring diagrams are not acceptable.
    e. Shop drawings provided by the equipment manufacturer shall show system details including location of FACPs, Network Display Units, Notification Appliance Circuit Expansion Power Supplies, TSWs, TrueSite Screens and Control Functions, all devices, circuiting, and details of interconnection. Include Fiber Optic installation and termination parameters.
    f. Shop drawings shall indicate circuit labels to be field applied. All circuit descriptions on the drawings shall be clearly labeled on the wiring as to its function and area served.
    g. Battery calculations showing total standby and total alarm power required to meet the specified system requirements and voltage drop calculations for the notification appliance circuits. Calculations shall clearly indicate existing and new devices.
    h. Submittal shall include all system power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate in accordance with the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
    i. Submittals shall include all system operation descriptions including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and

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outputs. A list of all inputs and outputs in the system shall be provided with a label indicating location or use of IDC, SLC, NAC, relay, sensor, and auxiliary control circuits.

j. Include operating instructions for each component of the Fire Alarm System.

1.10 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installers, technicians, and supervisors per Part 1 of this Section. Certifications to include Denver Fire Department, NICET, and the Manufacturer (Simplex).

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.11 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For systems and components to include in emergency, operation, and maintenance manuals.

1. Include operating instructions, and maintenance and repair procedures. Include data for each type of product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
2. Provide a minimum of three (3) copies in separate 3 ring binders. Also provide electronic copies of documents in format in conformance with Division 1 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. Record actual locations of components and instrumentation.

C. All components of this system and its installation shall be documented and maintained on accurate record drawings and with electronically created files. If this project is not designed using the DEN Autodesk Revit/BIM model, then complete and accurate record drawings shall be provided to the DEN BIM Department for inclusion in the official Revit model for the building. The Contractor shall be responsible for turnover of all paper and electronic documents required by the DEN BIM Department prior to project close out.

D. Contractor shall maintain on site accurate record drawings indicating locations of constructed raceways, boxes, and devices. Any modifications to work depicted on the permitted shop drawings shall be noted. Record documents shall be updated daily and shall always be available for DEN review. The record drawings shall indicate the following:

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1. The locations and installation details of the installed equipment.
2. The location of all existing initiating devices and notification appliances.
3. The address of each addressable device.
4. The installed wiring and color coding and wire tag notations for the exact locations of all installed equipment.
5. Locations of each End-of-Line Resistor, End-Of-Line Device, and fault circuit isolator.
6. Specific point-to-point interconnections between all equipment and internal wiring of the equipment. Typical point-to-point wiring diagrams are not acceptable.
7. The locations of all raceways and junction boxes.
8. Dated sequence of operations matrix and battery and voltage drop calculations.

E. Submit Record Drawings per Division 01. “As Built” Plans shall be provided in the same format and manner as described for Installation Drawings.

1. Conform permitted shop drawings to project record drawings, including accurate and correct locations of raceway, box, and device locations.
2. Include electronic copy of record drawings in compliance with Division 1 requirements.
3. Install two (2) full size copies of drawings in the Building Fire Command Center.

1.12 ENGINEERED SYSTEM PROGRAM AND COMPUTER GRAPHICS MODIFICATIONS

A. System Programming and Graphics Modifications: The Contractor shall contract with SimplexGrinnell for the following:

1. Software Modifications: Provide software modification in compliance with NFPA 72 and consistent with Contract Documents. This includes but is not limited to development, installation and testing of customized software programming modifications for complete system modifications, including but not limited to software modifications for Fire Alarm Master Panel, Fire Alarm Remote Panel, and 4100ES/4120 installations. Provide update of Message and Zone files in hard copy form and install hard copies in FCC hard copy records system.
2. Graphics Modifications: The TSW updates shall be graphically noted to identify that the added graphics is work “Under construction” during migration. This annotation shall be removed at the time of system acceptance by the Denver Fire Department.
3. Operation of software during testing: Provide onsite presence of a programming technician during all system testing as defined in Part 3 of this Section.

1.13 PERMITS AND APPROVALS

A. Construction permits shall be obtained and paid for by the Contractor unless otherwise indicated by the DEN Project Manager. Prior to commencement and after completion of Work, the Contractor shall be responsible for securing all necessary permits and scheduling all inspections with the appropriate AHJ.

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1.14 TESTING, REPORTS, AND CERTIFICATIONS

A. Testing, Reports and Certifications shall be in accordance with Part 3 of this Section.

B. Testing: Submit testing procedure and recording forms for each component of the system to DEN for review and approval. Upon approval and successful testing, these forms shall be completed and saved for record purposes.

1.15 QUALITY ASSURANCE

A. The Contractor shall be fully responsible for daily quality control of all system installation, coordination with trades, and coordination with DEN Maintenance (Life Safety) and Engineering. Observation by DEN of work identified in Part 3 of this Section does not take the place of the Contractor's Quality Control Program or relieve the Contractor of Quality Control responsibilities.

B. Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

C. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Service personnel shall have the same certifications as required for system installers.

D. The Contractor shall provide qualified fire alarm installers licensed as Fire Alarm System Installer/Journeyman in accordance with the Denver Fire Department, Fire Prevention and Investigation Division – Licensing Program. In addition, a NICET Level 2 certified technician/installer shall be provided to supervise the work of each crew of four installers. The NICET Level 2 technician is not required to be the crew foreman.

E. The installation of this system is to be performed under the direct supervision of the manufacturer. The certification and record of completion of each component shall be prepared by the installing contractor and manufacturer after performing all pertinent tests.

F. The system shall be installed under the supervision of a qualified, trained NICET (minimum Level 3) Certified SimplexGrinnell representative/technician. The system shall be demonstrated to perform all of the functions as specified. A single NICET (minimum Level 3) Certified SimplexGrinnell representative shall supervise the entire project. Programming and project oversight may be provided by other SimplexGrinnell representatives under the supervision of the NICET Level 3 Certified individual.

G. The manufacturer's technician shall have at least five (5) years' experience installing fire detection, alarm, and control systems. The technician and the technician's qualifications shall be presented, and be acceptable to the Owner's Designated Representative. Once assigned, SimplexGrinnell's fire alarm and emergency communications system technicians shall not be changed without the approval of the DEN Project Manager.

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H. The manufacturer's supervisory work shall include, but not necessarily be limited to, checking all the system wiring connections; advising the Contractor installation team members regarding technical details of the installation; and the adjustment and testing of all components of the system in order to ensure a complete and fully operable system.

I. A manufacturer's technician shall be on site, as required by the DEN Project Manager, during migration and reconnection of the new equipment. The technical representative shall monitor all wiring changes and assist the Contractor installation team members to ensure a smooth transition to the newly installed equipment.

1.16 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site per the provisions of Division 01.

B. Store and protect products per the provisions of Division 01.

1.17 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. All components, parts and assemblies supplied by the manufacturer shall be guaranteed against defects in materials and workmanship for a period of (36) months following Substantial Completion. Submit warranty per Division 1 requirements.

B. Warranty service shall be provided by a trained specialist of the equipment manufacturer, who shall be based in a fully staffed, fully stocked (replacement parts and test equipment) office, located within 50 miles of the project site.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Minimum [**five (5)**] <**Insert number**> years from date of Substantial Completion.

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

2.1 GENERAL

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A. Fire alarm system equipment shall be new, standard components, regularly manufactured by SimplexGrinnell except as noted herein.

B. All systems and components shall have been thoroughly tested and proven in actual use.

C. Equipment from a different manufacturer may only be used where identified in the Contract Documents or accepted in writing by the Engineer and DEN Project Manager.

D. For additions to the Airport Office Building, Central Utility Plant, Concourse A, the AGTS Maintenance Building, and certain AGTS spaces between the AGTS tunnels, standard visual notification and standard audible notification appliances shall be manufactured by Eaton Cooper Notification (i.e., Wheelock).

E. For additions to the Terminal, Concourse B, and Concourse C, addressable visual notification and addressable audible notification appliances shall be manufactured by SimplexGrinnell.

F. Where equipment of different manufacturers is used, such equipment shall be UL listed and labeled as an integrated fire alarm system and certified as compatible with SimplexGrinnell systems (e.g., solenoids for pre-action sprinkler systems).

2.2 STANDARD NOTIFICATION POWER EXTENDER PANELS

A. Standard notification shall be provided in the Airport Office Building, Central Utility Plant, Concourse A, the AGTS Maintenance Building, and in certain AGTS spaces located between the AGTS Tunnels.

1. The IDNet NAC Power Extender panel shall be a stand-alone panel capable of powering a minimum of 4 notification appliance circuits. Notification appliance circuits shall be Class B, Style Y rated at 2 amps each. Panel shall provide capability to be expanded to 8 notification appliance circuits. Simplex 4009-9201.
2. The internal power supply & battery charger shall be capable of charging up 12 Ah batteries internally mounted.
3. The NAC extender panel may be mounted close to the host control panel or can be remotely located. The IDNET Addressable NAC Extender Panel, when connected to an addressable panel, shall connect to the host panel via an IDNet communications channel. Via the IDNET channel each output NAC can be individually controlled for general alarm or selective area notification.
4. Alarms from the host fire alarm control panel shall signal the NAC power extender panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble conditions to the host panel.
5. The IDNet NAC Power Extender panel shall be a stand-alone panel capable of powering a minimum of 4 notification appliance circuits. Notification appliance circuits shall be Class B, Style Y rated at 2 amps each. Panel shall provide capability to be expanded to 8 notification appliance circuits. The strobes shall not drift out of synchronization at any time during operation. If the sync module or Power Supply fails to operate, (i.e., contacts remain closed), the strobe shall revert to a non-synchronized flash-rate. The appliance shall also be designed so

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that the audible signal may be silenced while maintaining strobe activation when used with Wheelock synchronization.

6. The IDNet NAC Power Extender panel shall have the Wheelock Patented Sync Protocol integrated into the panel for strobe synchronization, and not require the use of external sync modules. All IDNet NAC Power Extender panels and internal 4100ES power supplies shall sync together on the host 4100ES panel.
7. Node to node synchronization of strobes shall be required.
8. For IDNet connected NAC extender panels up to ten (10) panels can be connected on a single IDNet channel.

2.3 ADDRESSABLE NOTIFICATION POWER PANELS

A. Addressable notification shall be provided in the Terminal (Main and North), Concourse B, and Concourse C.

B. Addressable notification shall be powered and controlled by Enhanced Power Supplies (EPS). With IDNac SLCs to addressable notification appliances, a constant 29 VRMS source voltage is maintained, even during battery standby, allowing strobes to operate at higher voltage with lower current and ensuring a consistent current draw and voltage drop margin under both primary power and secondary battery standby.

C. IDNac SLC power supplies shall provide three on-board 3 Amp IDNac SLCs. Each SLC shall provide up to 63 addresses and up to 75 unit loads. Simplex 4100-5325.

D. The EPS power supply shall be mounted in an FACP or Transponder as specified by SimplexGrinnell.

E. Each IDNac addressable notification appliance shall be individually programmed and controlled for general alarm or selective area notification.

F. The host fire alarm control panel shall signal the IDNAC power supply to activate. The panel shall monitor itself and each of its IDNACs for trouble conditions and shall report trouble conditions to the host panel.

G. The IDNac Power Supply shall have the Simplex Sync Protocol integrated into the panel for strobe synchronization, and not require the use of external sync modules. All IDNac Power Supplies and internal 4100ES power supplies shall sync together on the host 4100ES panel.

H. Node to node synchronization of strobes shall be required.

I. If required, field-mounted 4009 IDNac Repeater Panels shall be used to extend the power and distance of the IDNac SLCs. The Repeater shall provide an additional 3 Amps of power and requires one IDNac SLC address. Repeaters can be connected as one in series or up to five (5) in parallel. The Repeater shall include a built-in battery charger and charge up to 12.7 Ah batteries for in cabinet mounting. Simplex 4009-9601.

2.4 INITIATING DEVICES

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A. General:

1. Devices shall receive power and communication from the same pair of wires. For fault-tolerant circuits, any separate power wiring shall also be made fault-tolerant.
2. All sensors shall be of the intelligent type. All sensors shall mount on a common base.
3. Conventional fire alarm initiating devices (manual pull stations, waterflow and tamper switches, pressure switches) shall each be individually addressable via addressable modules.

B. Addressable Manual Pull Stations:

1. Addressable double-action push-pull type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station shall mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units. Simplex 4009-9003.

C. Conventional Manual Pull Stations:

1. Conventional and weatherproof manual pull stations shall be provided where required and indicated on the drawings.
2. Conventional manual pull stations shall be capable of being opened without initiating an alarm condition. Provide Firelite model BG-12 product line, dual action. Standard models will be:

    a. Conventional: Firelite BG-12L.
    b. Weatherproof: Firelite BG-12LOB.

D. Smoke Sensors:

1. Smoke sensors shall be of the photoelectric or combination photoelectric / heat type. Simplex 4098-9714 photoelectric sensor, Simplex 4098-9754 combination photoelectric/heat.
2. Relay output, sounder and isolator bases shall be supported alternatives to the standard base. Address shall reside in the detector base and not the sensor. Simplex 4098-9792 (4098-9789 with remote LED driver) and 4098-9832 trim ring.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
4. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove the detector head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
5. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit. In alarm condition, the sensor base LED shall be on steady.
6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
7. Each sensor shall be scanned by the Control Unit for its type identification to

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prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135°F and 15°F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.

8. The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI.
9. Sensors shall include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP.
10. Removal of the sensor head for cleaning shall not require the setting of addresses.
11. Device address shall reside in the permanently installed base.
12. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
13. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
14. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 selectable sensitivity levels ranging from 0.2% to 3.7%/ft obscuration, programmed and monitored from the FACP.
15. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a TSW or printed for annual recording and logging of the calibration maintenance schedule.
16. Sensor Cleaning: The FACP shall automatically indicate when an individual sensor needs cleaning. A trouble condition shall be activated when a sensor's average value reaches a predetermined value indicating that it is dirty. Three (3) progressive levels of reporting shall be provided.
17. Almost Dirty: The first level shall indicate if a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY SENSOR." This condition provides a means to alert maintenance staff of a sensor approaching dirty without creating a trouble in the system.
18. Dirty Sensor: If the first level indicator is ignored and the second level is reached, a "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported to the Supervising Station. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor.
19. Excessively Dirty: If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.
20. Sensor Self-Test: The FACP shall continuously perform an automatic self-test on each sensor that will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
21. Multi-Sensors: Multi-Sensors shall combine photoelectric smoke sensing and heat sensing technologies. An alarm shall be determined by either smoke

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detection, with selectable sensitivity from 0.2 to 3.7 %/ft obscuration; or heat detection, selectable as fixed temperature or fixed with selectable rate-of-rise; or based on an analysis of the combination of smoke and heat activity. Each detection type shall be independent operation from the other and not combine sensing technologies.

22. Magnet Test: Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.
23. Smoke detectors associated with suppression release shall be provided with a red detector base or separate red base ring.

E. Duct Smoke Sensor

1. Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions. Sensor includes relay as required for fan shutdown. Simplex 4098-9756 housing with 2098-9806 remote test/LED station.
2. Duct detectors shall be readably accessible and located and installed to allow testing, removal, and replacement without disassembly of any other equipment or building items.
3. The Air Duct Housing unit shall be designed for detection of combustion products and/or smoke in air conditioning and ventilation system ducts in compliance with National Fire Protection Association Standard 90A. The assembly shall consist of a housing to accommodate sampling tubes that extend into and across the duct to the ventilation system.
4. The sampling chamber shall be designed to ensure uniform sensitivity in air velocities from 500 feet per minute to 4000 feet per minute. Inlet sampling tube length shall be determined by the width of the air duct being protected.
5. While the fans are operating, a continuous cross-sectional sampling of air from the duct shall flow through the selected photoelectric detector, after which the sampled air shall be returned to the duct.
6. Air handling equipment shall incorporate air duct detectors per code requirements. The air duct housing shall incorporate a relay to shut down the air handling devices in addition to sending a supervisory alarm signal to the FACP. The housing shall contain a LED to indicate when the detector is in alarm.
7. The Air Duct Housing shall be mounted directly outside of the air duct. A template shall be provided for making necessary cut-outs and holes. Complete instructions shall be supplied with the unit.
8. Detectors shall operate on 24 VDC, and shall be powered from the panel via separate 24 VDC supply circuit.
9. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACP.
10. The Duct Housing shall provide an auxiliary relay. This auxiliary relay output shall be fully programmable.
11. Duct Housing shall provide a relay control trouble indicator Yellow LED.
12. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
13. Duct Housing shall provide a magnetic test area and Red sensor status LED.
14. For maintenance purposes, it shall be possible to clean the duct housing

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sampling tubes by accessing them through the duct housing front cover.

15. Each duct smoke sensor shall have a Remote Test Station with an alarm LED and test switch mounted at an accessible location no more than 7 feet above finished floor.
16. Where indicated, provide NEMA 4X weatherproof duct housing enclosures that shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.

F. Air Sampling Duct Detectors

1. Provide a Simplex XAD100 or XAD200 when duct smoke detectors are required to be provided at locations that are inaccessible for maintenance as identified on the shop drawings. Coordinate applicable locations with DEN maintenance/Life Safety personnel. DEN Life Safety to approve in advance the installation of any air sampling duct detection.

G. Beam Smoke Detectors

1. Provide Xtralis OSID Smoke Detectors, or approved equal. Features of beam detectors shall include the following:

    a. Operates over distances between up to 500 ft (153 m).
    b. Built-in alignment sights and tamper protection.
    c. Automatic range adjustment, signal synchronization, and contamination adjustment.
    d. To be supplied with permanent power, not battery operated.

H. Heat Sensors

1. Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135°F fixed-temperature with rate of rise setting except as indicated. Simplex 4098-9733.
2. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
3. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135°F or 155°F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15°F or 20°F per minute.
4. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32°F to 155°F.

I. Combination Smoke and Heat Sensor

1. The combination smoke and heat sensor shall comply with applicable sections above for both functions. Simplex 4098-9754.

J. Conventional Heat Detectors

1. Where required due to ambient conditions, a conventional fixed temperature heat

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detector shall be provided. Use Thermotech Model 302, labeled as Simplex 2098-9486, or approved equal.

2.5 MODULE DEVICES

A. Monitor Modules: The Monitor Module shall provide an addressable input for N.O. or N.C. contact devices including but not limited to manual stations, water-flow switches, sprinkler supervisory devices, temperature sensors, door contacts, fire\smoke dampers, intrusion detectors, etc. The Monitor Module shall provide a supervised initiating circuit. Upon determination of an alarm condition, the LED shall be latched on. The Module shall contain a LED that blinks upon being scanned by the FACP. The Module shall mount in a standard electrical box. Simplex 4090-9001.

B. Control Modules: The Control Module shall provide an addressable output for a separately-powered alarm-indicating circuit or for a control relay. The Control Module shall provide a supervised indicating circuit where indicated on the plans. An open-circuit fault shall be annunciated at the FACP. The Control Module shall provide a control relay where indicated on the plans. The relay contacts shall be SPST (Form "C" rated at 2 amps @ 28 VDC). Voltage on detector contacts shall not exceed 24 Volts. The module shall contain an LED that blinks upon being scanned by the FACP. The module shall mount in a standard electrical box. Simplex 4090-9002.

C. Control Relays: Provide control relays compliant with Code requirements. Provide control relays as required to accomplish functions such as fan shut-down, damper positioning, device release, etc. Relays shall have 24 VDC coils, with DPDT contacts rated at 10A, minimum, at 120 VAC, shall be provided with screw terminals, and shall be UL listed as fire alarm control accessories. Relay enclosures shall provide conduit knockouts at top and bottom, and shall have manufacturer's standard finish. Control relays shall be installed near the associated fire alarm system control modules. Control relays shall be individually programmable by the system to respond automatically in the event of an alarm by related sensors or other devices. Manual control of fans, dampers and required relays shall be provided, as well as automatic control where required. Control sequences shall be as indicated on related mechanical systems control drawings. Simplex 2088-9021 or equal.

D. Fault Isolator Module: The Fault Isolator Module shall detect and isolate a short-circuited segment of a fire alarm SLC. Simplex 4090-9116.

E. Addressable Circuit Interface Modules:

1. Arrange Addressable Circuit Interface Modules to monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of mechanical systems.
2. Addressable Circuit Interface Modules shall be capable of mounting in a standard electric outlet box. Modules shall include cover plates to allow surface or flush mounting. Modules shall receive their operating power from the signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.

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3. There shall be the following types of modules:

   a. Type 1: Monitor Circuit Interface Module:

      1) For conventional 2-wire smoke detector and/or contact device monitoring with Class B supervision. The supervision of the zone wiring shall be Class B. This module shall communicate status (normal, alarm, trouble) to the FACP. Provide 4090-9101 Monitor ZAM, with 4090-9801 (semi-flush) or 4090-9802 (surface) 4” square / 2 gang cover with LED viewport which indicates device status.
      2) To eliminate the requirement for additional addressable modules, associated installation, programming, and service requirements, provide monitor modules with built-in power reset capability for conventional 4-wire smoke detector with Class B wiring supervision. The module shall provide detector reset capability and over-current power protection for the 4-wire detector. This module shall communicate status (normal, alarm, trouble) to the FACP. Provide 4090-9101 Monitor ZAM, with 4090-9801(semi-flush) or 4090-9802 (surface) 4” square / 2 gang cover with LED viewport which indicates device status.
      3) Relay IAMs without LED indication are not acceptable (e.g., 4090-9118).

   b. Type 2: Line Powered Monitor Circuit Interface Module

      1) Where required, provide individually addressable modules that have both power and communications supplied by the two-wire signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP. Provide Simplex 4090-9001 Monitor IAM with 4090-9806 (semi-flush) or 4090-9807 (surface) cover for single gang box with viewport of device status LED.
      2) Where required, provide modules with location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module. Simplex 4090-9121 IAM.

   c. Type 3: Single Address Multi-Point Interface Modules

      1) Where control and monitoring are required at one location, provide efficient multi-state modules to decrease the quantity of addressable devices and potential service issues, and to increase overall efficiency of the system. This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of

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communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately. Provide Simplex 4090-9120, with 4090-9801 (semi-flush) or 4090-9802 (surface) 4” square / 2 gang cover with LED viewport that indicates device status.

2) Provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module. This module shall have a control point output, and monitor 2 points of inputs in a common device. Simplex 4090-9118, with 4090-9801 (semi-flush) or 4090-9802 (surface) 4” square / 2 gang cover with LED viewport which indicates device status.

3) This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module. Provide Simplex 4090-9119 with 4090-9801 (semi-flush) or 4090-9802 (surface) 4” square / 2 gang cover with LED viewport that indicates device status.

4. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.
5. The system shall support 100% of addressable devices in alarm or operated at the same time. Simultaneous operation of each and every control point shall be sustainable even during the condition when every addressable point is in alarm or active condition, under both primary (AC) and secondary (battery) power conditions."

2.6 SUPPRESSION INTERFACE DEVICES

A. Fire Suppression (Pre-Action / Deluge) Releasing Peripherals

1. Interface to Fire Suppression Releasing Solenoids shall be through UL Listed Fire Releasing Peripheral, Simplex 4090-9006. This device provides supervised control circuitry to the solenoid, and receives dual inputs from the associated FACP to ensure suppression release is activated only upon confirmed alarm conditions and not inadvertently tripped by a single operation.
2. Connect this releasing peripheral to solenoids UL listed as compatible with the releasing peripheral. Replace all existing solenoids that will be connected to a new Fire Suppression Releasing Solenoid with a listed compatible solenoid.
3. Provide Simplex 2081-9046 Coil Supervision Modules at the Solenoid location to

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monitor the electrical integrity of the releasing solenoid.

4. Provide Simplex 2080-9059 Maintenance Switch with Disconnect Lamp, or approved equal, for prevention of accidental discharge during normal maintenance of the releasing system.

2.7 NOTIFICATION DEVICES

A. The fire alarm system shall interface with the existing ECS. Audible notification of fire events and non-fire events shall occur through the ECS. Visual indication shall be powered and controlled by the fire alarm system. Textual visual notification shall be a combination of fire alarm and ECS controlled signage.

1. Audible devices powered and controlled directly from the fire alarm system shall be limited to auxiliary devices provided to meet specific notification requirements (e.g., audible devices at sprinkler fire department connections) and in areas where ECS audibility or intelligibility cannot be provided, (e.g., electrical and mechanical rooms).
2. Horn/Strobes and Strobes:

3. Electronic fire alarm signals shall be combination horn and strobe type or strobe only type where shown on drawings. The audible signal and strobe shall operate independently or in unison.
4. Devices shall be mounted on ceilings or on walls as indicated on Contract Documents, and shall be UL listed for specific mounting configuration. Column-mounted devices in equipment rooms shall be surface-mounted. Mounting height of devices on columns or walls shall comply with NFPA and ADA requirements.

B. Notification Appliance Circuit provides synchronization of strobes at a rate of 1Hz. The capability to synchronize multiple notification appliance circuits shall be provided.

C. Standard Notification Appliances

1. Standard notification appliances shall be provided in the Airport Office Building, Central Utility Plant, Concourse A, the AGTS Maintenance Building, and in certain AGTS spaces located between the AGTS Tunnels.
2. The standard notification appliances shall be Wheelock® Exceder™ Series HS Audible Strobe appliances, Series ST Visual Strobe appliances and Series HN Audible appliances or approved equals. The Series HS and ST Strobes shall be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service. The Series HS and HN Audibles shall be UL Listed under Standard 464 (Fire Protective Signaling). All Series shall meet the requirements of FCC Part 15 Class B. All inputs shall be compatible with standard reverse polarity supervision of circuit wiring by a FACP with the ability to operate from 8 to 33 VDC. Indoor wall models shall incorporate voltage test points for easy voltage inspection.
3. Standard models will be:

    a. HSW-AL.

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b. HSWC-AL.
c. STW-AL.
d. STWC-AL.

4. The Series HS Audible Strobe and ST Strobe appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range and shall incorporate a Xenon flash tube enclosed in a rugged Lexan® lens. The Series shall be of low current design. Where Multi-Candela appliances are specified, the strobe intensity shall have 8 field selectable settings at 15, 15/75, 30, 75, 95, 110, 135, 185 candela for wall mount and 15, 30, 60, 75, 95, 115, 150, 177 candela for ceiling mount. The selector switch for selecting the candela shall be tamper resistant. The 15/75 candela strobe shall be specified when 15 candela UL Standard 1971 Listing with 75 candela on-axis is required (e.g. ADA compliance). Appliances with candela settings shall show the candela selection in a visible location at all times when installed.
5. The audible shall have a minimum of three (3) field selectable settings for dBA levels and shall have a choice of continuous or temporal (Code 3) audible outputs. Audible notification shall utilize temporal (Code 3) outputs.
6. The Series HS Audible Strobe, ST Strobe and Series HN Audible shall incorporate a patented Universal Mounting Base that shall allow mounting to a single-gang, double-gang, 4-inch square, 3.5-inch octal, 4-inch octal or 100mm European type back boxes. Two wire appliance wiring shall be capable of directly connecting to the mounting base. Continuity checking of the entire NAC circuit prior to attaching any notification appliances shall be allowed. Product shall come with Contact Cover to protect contact springs. Removal of an appliance shall result in a supervision fault condition by the FACP. The mounting base shall be the same base among all horn, strobe, horn strobe, wall, and ceiling models. All notification appliances shall be backwards compatible.
7. The Series HS and ST wall models shall have a low profile measuring 5.24” H x 4.58” W x 2.19” D. Series HN wall shall measure 5.24” H x 4.58” W x 1.6” D. The Series HSC and STC shall been round and have a low profile with a diameter of 6.68” x 2.63” D. Series HNC ceiling shall have a diameter of 6.68” x 1.50” D.
8. When synchronization is required, the appliance shall be compatible with Wheelock®’s SM, DSM Sync Modules, Wheelock® Power Supplies or other manufacturer’s panels with built-in Wheelock® Patented Sync Protocol. The strobes shall not drift out of synchronization at any time during operation. If the sync protocol fails to operate, the strobe shall revert to a non-synchronized flash-rate and still maintain (1) flash per second over its Regulated Voltage Range. The appliance shall also be designed so that the audible signal may be silenced while maintaining strobe activation when used with Wheelock® synchronization protocol.
9. Wall Appliances – UL Standard 1971, UL Standard 464, California State Fire Marshal (CSFM), ULC, FM.
10. Ceiling Appliances – UL Standard 1971, UL Standard 464, California State Fire Marshal (CSFM), ULC, FM.
11. Color:

    a. White for Public and Sterile Areas including AOB Level 6-10, all AGTS Stations, Concourses Level 2 and above, and Terminal Levels 5 and 6.
    b. Red for back-of-house areas including AOB Level 4, 5A, 5B, and 11,

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Central Plant, Concourses Level 0 and 1, Terminal Level 3 and 4, and the AGTS Maintenance Building.

12. For outside or unconditioned locations, provide weatherproof appliances, Wheelock ASWP Audible Strobes or approved equal.

D. Addressable Notification Appliances:

1. Addressable notification shall be provided in the Terminal (Main and North), Concourse B, and Concourse C.
2. The addressable notification appliances shall be Simplex TrueAlert ES Addressable Notification Appliances series Audible/Visual appliances, Visual Strobe appliances, and Audible appliances or approved equals. The Strobes shall be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service. The Audibles shall be UL Listed under Standard 464 (Fire Protective Signaling). All inputs shall be compatible with addressable notification controlled by IDNac SLCs from Simplex 4100ES fire alarm control panels with EPS/EPS+ power supplies and 4009 IDNac Repeaters providing a regulated 29VRMS allowing strobes to operate with lower current even under battery backup.
3. Standard models will be:

    a. 49VO-WWA (Strobe, Wall, White, ALERT).
    b. 49VO-WRA (Strobe, Wall, Red, ALERT).
    c. 4906-9204 w/ White Alert Cover (Strobe, Ceiling, White, ALERT).
    d. 4906-9202 w/ Red Alert Cover (Strobe, Ceiling, Red, ALERT).
    e. 49AV-APPLW, 49AVC-WRALT, 49MP-AVVOWR (Horn/Strobe, Wall, Red, ALERT).
    f. 49AV-APPLW-O, 49AVC-WRALT-O,49WPBB-AVVOWR (Horn/Strobe, Wall, Red, ALERT, Weatherproof).
    g. 49AV-APPLW-O, 49AVC-WRFIRE-O, 49WPBB-AVVOWR (Horn/Strobe, Wall, Red, FIRE, Weatherproof, for use at Fire Department Connections).

4. Strobe appliances shall produce a flash rate of one (1) flash per second over the Regulated Voltage Range and shall incorporate a Xenon flash tube enclosed in a rugged Lexan® lens. Where Multi-Candela appliances are specified, the strobe intensity shall be programmable from the control panel or jumper selected as 15, 30, 75, 110, 135, or 185 candela for wall mount and 15, 30, 75, or 110 candela for ceiling mount. Appliances with candela settings shall show the candela selection in a visible location at all times when installed.
5. The audible shall have a minimum of two (2) field selectable settings for High or Low dBA levels and shall have a choice of continuous or temporal (Code 3) audible outputs. Audible notification shall utilize temporal (Code 3) outputs.

    a. Separate covers shall be available to change application type on-site or for replacement. A separate mounting plate shall allow wiring to be completed before appliance is mounted. Mounting place shall allow mounting to a single-gang, double-gang, or 4-inch square back box, flush or surface mount.

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6. Wiring supervision to each appliance shall allow “T-tapped” connections for Class B circuits to simplify wiring. Wiring shall be unshielded twisted pair (UTP).
7. Strobes shall be synchronized, 1 Hz flash.
8. Wall Appliances – UL Standard 1971, UL Standard 464, California State Fire Marshal (CSFM), ULC, FM
9. Ceiling Appliances – UL Standard 1971, UL Standard 464, California State Fire Marshal (CSFM), ULC, FM
10. Color:

    a. White for Public and Sterile Areas including AOB Level 6-10, all AGTS Stations, Concourses Level 2 and above, and Terminal Levels 5 and 6.
    b. Red for back-of-house areas including AOB Level 4, 5A, 5B, and 11, Central Plant, Concourses Level 0 and 1, Terminal Level 3 and 4, and the AGTS Maintenance Building.

11. For outside or unconditioned locations, provide weatherproof appliances.

2.8 REMOTE LIGHTS

A. Remote indicating lights shall be provided only as indicated on the drawings, but are not generally required due to the use of the color graphic workstations (TSW).

B. Remote indicators installed for monitoring of mechanical equipment shall be installed within 7’0” of floor level and directly beneath the equipment.

C. Exterior remote lights shall not be provided. All existing exterior remote lights associated with applicable project shall be removed.

2.9 MAGNETIC DOOR HOLDERS

A. Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develop a minimum of 25 lbs. holding force. Simplex DH24120 Series, or equal.

B. Mount any new outlet boxes for electric door holder to withstand 80 pounds pulling force. Evaluate condition of existing boxes and repair as necessary.

2.10 SUPPRESSION INTERFACE DEVICES

A. Tamper Switches: Installed under a separate specification section, connection completed and tested under these specification requirements.

B. Flow Switches: Installed under a separate specification section, connection completed and tested under this specification requirements.

C. Sprinkler Pre-action Solenoid and Deluge Valves: Installed under a separate specification section, complete with devices as required to provide for fire alarm

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system monitoring and control functions.

D. Differential Pressure Switch: Installed under a separate specification section, connection completed and tested under this specification requirements. Pressure switches to be configured based on a separate specification section, but could consist of separate low air and alarm (high) pressure switches or a single device with two sets of contacts for the two pressure conditions.

E. Damper End Switches: Installed under a separate specification section, connection completed and tested under this specification requirements. Coordinate with mechanical Contractor.

2.11 BATTERIES

A. Standby Batteries capable of operating all fire alarm panels shall be provided to automatically back up the normal power. The system shall have the capacity to operate a FACP or NAC Power Extender panel for 24 hours and workstations for four hours, and then operate the fire alarm indicating devices for at least fifteen minutes. When commercial power is restored, the system shall transfer automatically to primary power and shall not cause an alarm. System power supply shall be equipped with battery charging circuits sufficient to recharge fully depleted batteries to within 70 percent of their maximum capacity within 12 hours.

1. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 15 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
2. All TSWs shall be provided with Uninterruptible Power Supplies to support full operation for four hours.
3. Batteries shall be sized with a spare capacity of 20%.

2.12 WIRING

A. All wiring shall be of the type as specified herein and as recommended by the manufacturer. All wire shall be installed in conduit throughout.

B. All Fire Alarm System wiring shall comply with NEC and NFPA requirements for power limited wiring.

Circuit:	**Color (*):**	**Color (-):**	**Size AWG:**	**Type:**	**Insulation Type:**
Audible NAC (Horn Only)	Red*	Black	12	Stranded (19)	THHN
Visual NAC (Strobe or H/A)	Red*	Brown	12	Stranded (19)	THHN
IDC	Red w/white stripe	Black w/white stripe	16	Solid	TFN
SLC (IDNET)	Red	White	16	Solid, twisted pair	TFN

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Circuit:	Color (*):	Color (-):	Size AWG:	Type:	Insulation Type:
Remote Lights	Yellow	Purple	16	Solid	TFN
24 volt Power	Red	Black	14	Solid	THHN
RUI Communication	Red	Black	16	Solid, twisted	SHIELDED
Audio NAC (Fire Alarm Speaker)	Red	Black	16	Solid, twisted pair	SHIELDED
Duct Detector Remote Test Switch	Red/blue	Black/ brown	16	Solid	THHN
Addressable Notification (IDNac)	Red	Brown	12	Stranded (19), twisted pair	THHN, unshielded

C. Wire for test switches with indicating lights shall be a 16 AWG solid THHN wire with the following color code: (1) red + LED, (2) black - LED, (3) blue + Test Switch, and (4) brown – Test Switch.

D. Wire associated with the AGTS Train Platform deluge systems activation circuits (i.e., key activated stations) shall be an IDC with blue (+) and white (-) wire.

E. Audio wire requirements shall be per Division 27 Communications, for Emergency Communications Systems.

F. Subject to compliance with Simplex and NEC requirements, local suppliers include but are not limited to the following: Liberty, Westpenn, ALLCABLE

G. All wiring shall test free from grounds and short circuit faults. No connections to the FACP shall be made until the system wiring has been accepted by the Owner’s Designated Representative and the equipment supplier.

H. Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the AHJ and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70, National Electrical Code (NEC).

I. Contractor shall obtain from the Fire Alarm System Manufacturer written instructions regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer, the Engineer, and the DEN Project Manager.

J. Existing wiring may only be used if warranted as new and with approval by the Engineer and the DEN Project Manager.

K. SLC communication (IDNet) and RUI channels shall utilize 16 Gauge solid twisted wire. The wire installed shall not exceed 35 pF/ft and shall have a minimum of 4 twists per foot. These wiring guidelines allow for a distance of 3600ft to the furthest device on a channel with a maximum of 250 devices, and an overall wire length of 10,000 ft. No SLC channel shall exceed .60 uF total capacitance and 35 Ohms resistance. Any conduit that is used for multiple circuit types along with 1 or more SLC channels shall conform to the table below.

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Circuit List 1	**Wiring Requirements**	**Circuit List 2**	**Wiring Requirements**
DC NAC	Any NEC 760 wire	TrueAlert Addressable	Any NEC 760 wire
Analog Audio Riser	TSC on analog riser only	RUI/RAI/RSI	Any NEC 760 wire
Digital Audio Riser	UTP on digital riser only	(Another) IDNet+ Channel	Any NEC 760 wire
4100U Speaker NAC	UTP on Speaker NAC only	MAPNET II Isolated	Any NEC 760 wire
(Other) Speaker NAC	TSP on Speaker NAC only	MAPNET II Non-isolated	TSP on MAPNET II only
Remote Microphone	TSP on remote microphone only	Network Communications	UTP on Network only
Firefighter's Telephones	TSP on telephone wiring only		

1. UTP = Unshielded Twisted Pair wiring; TSP = Twisted Shielded Pair wiring
2. 4 100U MAPNET communications can be selected as either isolated or non-isolated. Refer to installation instructions 579-022 for details.
3. Interaction between other types of circuits must still be considered (e.g., Speaker NAC and RUI/RAI/RSI, Firefighter's Phone &Network Communications, etc.) Refer to 900-242 Field Wiring Specifications for details.

L. Addressable notification IDNac SLC shall utilize unshielded twisted pair with a maximum wire length allowed with "T-Taps" for Class B wiring of 10,000 feet. Maximum wire length to any appliance shall not exceed 4,000 feet. Maximum wiring resistance between appliances shall not exceed 26 ohms.

M. Circuits in the same conduit are limited as follows:

1. Unless approved in writing by the Engineer and DEN Project Manager, wiring for NAC (standard NAC or addressable IDNAC) and SLC (IDNET) Circuits shall not be routed in the same conduit.
2. SLC circuits and 24 volt power from a fire alarm control panel may be routed in the same conduit. A maximum of 5 amps of 24 volt power shall be in the same conduit with SLC circuits.
3. No DC inductive loads greater than 5 amps 30VDC, or any AC voltage wiring, shall share the same conduit as an SLC circuit at any time.
4. RUI Communication shall always be shielded wiring if run in the same conduit with IDNET or IDNAC wiring.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

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1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. The Contractor shall provide a schedule to the DEN Project Manager indicating the installation sequence and time frame prior to beginning work. Where an existing system is being upgraded, this schedule shall include a detailed description indicating how the new system migration is to occur to ensure that the fire alarm and emergency communications system will be out of service for not more than 10 hours. The Contractor shall provide weekly updates to the DEN Project Manager.

B. Coordinate Work of this Section with other affected work and construction schedule. Submit a migration plan to “phase” the installation from the existing system to the new system. The submittal shall include sufficient details to clearly define which equipment will be installed during the phases, and how emergency response will be affected during the conversion process. This submittal shall address how emergency personnel will monitor and control the two operational systems during the conversion process.

C. Obtain Fire Department Permits and Electrical Rough-In Permits required for this installation.

D. The Contractor shall not order any equipment nor perform any installations prior to completion of review of the submittals by the DEN Project Manager and receipt of a written authority to proceed from the DEN Project Manager.

3.3 CONTRACTOR COORDINATION RESPONSIBILITIES

A. The Contractor shall coordinate Work in this Section with all related trades and ensure Work is performed. Where applicable, work and/or equipment provided in other sections and related to the fire alarm and emergency communications system shall include, but not be limited to:

1. Responsibility for all wiring up to and including connection to all existing and new sprinkler waterflow switches and any other sprinkler system supervisory switches. All sprinkler waterflow and supervisory switches shall be monitored for integrity in accordance with NFPA 72.
2. Verification of the quantity and location of all sprinkler waterflow and supervisory switches; additional sprinkler waterflow and supervisory switches shall be monitored accordingly and additional addressable monitor modules shall be installed and programmed, as necessary. Final locations shall be approved by the Owner’s Designated Representative.

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3. Responsibility for all wiring up to and including connection to a fire alarm relay adjacent to the elevator control unit. The Contractor shall provide the fire alarm relay and its enclosure, and shall coordinate the interconnection of the systems.

    a. Elevator recall is to be provided by the elevator contractor. The Contractor shall coordinate with the elevator contractor to interface the fire alarm system to the elevator controller.
    b. Responsibility for providing addressable modules for the signal connections to the fire pump controller. Fire pump supervision contacts shall be connected to the FACP in accordance with the current edition of NFPA 20.

4. Responsibility for all wiring up to and including connection to fire alarm relays adjacent to each HVAC system fan control.

    a. Fan control circuits are to be provided by the HVAC contractor. The Contractor shall provide the fire alarm relay and its enclosure. The Contractor shall coordinate with the HVAC contractor to interface the fire alarm system to the HVAC controller.
    b. Where smoke dampers are present in the building, they shall be controlled by the FACP and shall be programmed to operate as designed. The Contractor shall field verify quantity and location of dampers; additional control relay output modules shall be installed and programmed, as necessary. Final locations shall be approved by the DEN Project Manager. Confirm operation is in accordance with the Engineer’s matrix for sequence of operation.

5. Provide circuits for magnetic door hold-open devices such that upon alarm or loss of power, selected magnetic door hold-open devices shall release, allowing the held open door to automatically close.

3.4 PRE-WORK MEETING

A. The Contractor shall coordinate and arrange a pre-work meeting with the DEN Project Manager, DEN Project Inspectors and DEN Life Safety team one (1) week in advance of the beginning of any work. The Contractor shall assure attendance of trades installing the fire alarm system and systems controlled or monitored by the fire alarm system. The Contractor shall review the Contractor’s construction, demolition, phasing, implementation and testing plans, and schedule.

B. Meeting Notes: Meeting notes will be accurately recorded by the DEN Project Manager.

3.5 INSTALLATION

A. Furnish and install a complete fire alarm system as described herein and as indicated in the design drawings. Include sufficient control units and peripheral devices, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.

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B. All Contractors Work shall be performed in accordance with the best and the most modern practices of the trade. The final installation shall present a neat and workmanlike appearance.

C. The Contractor shall install the entire system in a workmanlike manner, in accordance with their standard instructions, and in accordance with their approved wiring diagrams unless otherwise specifically permitted by the DEN Project Manager, or as modified by this specification.

D. The Contractor shall be responsible for providing all additional raceways or wiring required, but not shown on the Contract Drawings. Included shall be all wiring required between control/auxiliary relays and monitor modules for the equipment to be controlled (i.e., EP/PE switches, motor control centers, individually mounted motor controllers, tamper switches, flow switches, and any other devices to which wiring connections are required for producing a complete and operational system).

E. Wiring/Signal Transmission:

1. Signal Transmissions: Transmission shall be hard-wired using addressable signal transmission, dedicated to fire alarm service only.
2. System Circuits:

    a. Initiating device circuits shall be Class B.
    b. Signaling line circuits shall be Class B.
    c. Notification appliance circuits shall be Class B.
    d. Network communications between system nodes shall be Class X using Optical Fibers.

3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the associated FACP and TSWs. Provide a distinctive indicating audible tone and alphanumeric annunciation, along with a graphical indication of the device and/or circuitry experiencing the trouble condition.
4. All fire alarm circuits shall be minimum Level 1 Survivable per NFPA 72.

F. Wire and Cable:

1. All wiring shall be new. Do not reuse salvaged conductors from this or any other projects without express written approval of the DEN Project Manager.
2. All wiring shall be installed in metal raceway or within equipment.
3. All wiring shall be installed continuous from device to device except where conduit length exceeds 300 feet or where agreed upon with DEN Project Manager. Raceways containing conductors identified as "fire alarm and emergency communications system" conductors shall not contain other conductors, and no AC carrying conductors shall be allowed in the same raceway with the DC fire alarm and emergency communications system detection and signaling conductors.
4. Conductors shall be installed in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and the requirements of this Section. Fire alarm conductors installed within equipment enclosures shall be carefully cabled.

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5. Approved branch circuits:

    a. Approved branch circuits shall be permitted as approved on the shop drawings.
    b. Approved branch circuits to a single device are permitted. Wire connections in a junction box used to connect the branch circuit to a single box shall utilize a Wago COMPACT connector, Ideal In-Sure push in connectors, or approved equal.
    c. Approved branch circuits to multiple devices are permitted only as approved by the DEN Project Manager in writing.

6. Individual conductors shall be tagged with markers indicating circuit number and type. Markers shall be used on all conductors at each outlet or pull box at each equipment enclosure. Reference Specification Section 260553 "Identification for Electrical Systems".
7. All wiring shall test free from grounds and short circuit faults. No connections to the FACP shall be made until the system wiring has been accepted by the Owner’s Designated Representative and the equipment supplier.
8. The field location of the End-of-Line Resistors (for non-addressable switches and devices) and fault circuit isolators shall be labeled so that the devices may be easily located. The location shall be noted on the point-to-point and record drawings.

G. Conduit: Conduits shall be installed in accordance with Section 260533 – Raceways and Boxes for Electrical Systems. All alarm wiring shall be installed in metal conduit, minimum of 3/4” EMT. Conduit shall be factory finished red.

1. Raceways shall be run parallel and perpendicular to the walls and ceilings. Wherever practical, exposed raceways shall be run on the ceiling as close as possible to a wall or as high as possible on a wall. Where concealed, provide access panels for all junction boxes, pull boxes and conduit bodies per NFPA 70 (NEC).
2. Where exposed raceways must cross under a structural beam or rib, they shall be run down one side of the beam or rib, across its bottom, and up to the ceiling on the other side of the beam or rib. No spanning from beam to beam or rib to rib will be permitted. The use of a conduit body on one side of a beam or rib will be permitted provided it will be readily accessible.
3. The method and location of all exposed conduit and raceways shall be approved by the Owner’s Designated Representative prior to start of any installation work.
4. All conduit shall be new unless approved in writing by the DEN Project Manager.

H. Where existing conduit is permitted to be reused based on other sections, conduits shall be supported in compliance with current NEC requirements and shall be painted red or labeled “FIRE ALARM” every 10 feet where accessible.

I. Boxes: As specified on fire alarm shop drawings. Outlet, pull and junction boxes shall be painted red on the exterior and shall be installed in accordance with Section 260533 "Raceways and Boxes for Electrical Systems". Box covers shall be painted red and identified by initiating and signaling line system numbers.

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J. Device installation:

1. Test stations and keys for any component testing should be accessible from the working surface (floor) without use of any lift equipment.
2. Detectors: All devices shall be installed to be fully accessible for testing and replacement. Elevated device locations shall be coordinated with other trades to assure direct access via ladders or lifts. Devices shall not be placed above conduit, duct work, lights, etc. Where devices are installed under raised floors, devices shall be located to assure direct access from the panel directly above the device without relocation of casework of fixed equipment.
3. Control Panels shall be located as indicated on dimensioned electrical plans and elevation drawings.
4. All modules and individual devices, including all initiating devices and notification appliances, shall be permanently marked with the system unique computer address. The marking shall be red numbers/letters on white background 3/8” high. When addresses are applied to the detector bases, they shall be located at the manufacturers point of test indicated on the detector. Remote test switches shall be labeled with their addressable device and the air handling unit number served.

K. Isolation Modules: Four (4) isolation modules shall be provided in the FACP for each IDNet+ circuit as a function of the SLC card. To the degree practicable, the SLC circuit shall utilize all four of these isolated circuits in the design. Additionally, fault isolator modules shall be provided at the following locations:

1. At each floor when an SLC serves multiple floors.
2. At any approved multiple device branch circuit.
3. After each IDNet NAC Power Extender panel or other types of NAC booster panels controlled by a SLC device. Note that this requirement may be reduced where multiple NAC Power Extender panels are located in close proximity to one another. In that configuration, provide fault isolation modules after the last NAC panel.

4. At other locations deemed appropriate by the DEN Project Manager.

L. Labeling: All field devices including initiating devices, monitor devices, control devices, and notification appliances shall be field identified with a permanent label. Labels shall indicate the complete device address including panel (node), circuit, and device designation. Label type, size, color and configuration shall be approved by the DEN Project Manager prior to installation.

M. All cutting, coring, and approved and listed fire stopping needed as a result of this work shall be the responsibility of the Contractor and shall be coordinated with the DEN Project Manager.

N. Equipment Removal

1. The Contractor shall completely remove the existing fire detection and alarm system control equipment, components and equipment that are not specified as being part of the new system. The equipment removed shall be boxed, labeled

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and shall be offered to the DEN Life Safety Team. Unaccepted equipment shall be disposed of by the Contractor. All unused, existing fire alarm and emergency communications system wire and cable shall be removed and properly disposed of off-site by the Contractor.

2. The Contractor shall perform all removal work efforts in accordance with the best and most modern practices.

O. All fire alarm panels shall have a smoke detector located within a distance of the panel location to comply with NFPA 72, including NAC Power Supplies.

3.6 SYSTEM INTERRUPTION

A. System interruptions shall be pre-approved by DEN Project Manager, DFD and the Engineer and detailed in the project's phasing/migration plan.

B. Interruption Request: Contractor must obtain all required signatures and written approval from DEN Maintenance Control for interruption and or disconnection of any fire alarm devices.

C. Fire Watch: The Contractor is responsible for maintaining a DFD approved fire watch during work on a system that has had an unplanned fire alarm system interruption, and until such time that the equipment has been restored.

D. Fire alarm and detection outages shall be minimized to the extent possible. Contractor shall coordinate all fire alarm system outages with the DEN Project Manager. Additionally, contractor shall install the new systems in a manner that will minimize the time that the fire alarm system is not functional.

E. The FACP shall be able to initiate notification devices in the building at all times unless special arrangements are coordinated with and approved by the DEN Project Manager.

F. Unless a fire watch is provided, either smoke detection or monitoring of the sprinkler system shall be provided for all areas of the building. If any area exists where both detection and monitoring of the sprinkler system is not available, a roaming fire watch shall be provided.

G. Contractor shall conduct as much of the work as possible with the FACP fully functional. Contractor is to wire initiating devices by area and connect to the FACP once wiring is completed.

H. If an unplanned fire alarm system interruption occurs for any reason, the Contractor shall instantly provide a roving fire watch and notify the DEN Project Manager.

I. If at any time building functions are bypassed, a fire alarm panel fire watch shall be provided. The panel fire watch shall be capable of initiating notification devices throughout the building.

3.7 FIELD QUALITY CONTROL

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A. Testing and Certification:

1. It shall be the responsibility of the Contractor to arrange for meetings, inspections and testing between the DEN representatives and DFD representatives. The Contractor shall provide qualified construction personnel knowledgeable of all NFPA fire alarm testing requirements during system testing. The Contractor may employ a company specializing in the maintenance, testing and central station monitoring of fire alarm systems.
2. The Contractor shall provide a detailed test plan that addresses sequence of testing as it relates to the overall project schedule, tests to be performed, and organizations required to be notified and/or present at each test. Contractor shall coordinate test plan with the DEN Project Manager and Engineer. The final test plan shall be submitted to the AHJ for acceptance.
3. Overtime testing for all activities that will cause public inconvenience should be provided. DEN Life Safety should be included as a required presence in all proof testing with DFD.
4. All tests and test documentation shall comply with NFPA 72. Contractor shall provide an executed Record of Completion prior to requesting a Demonstration Test with the DEN Project Manager and Engineer.
5. All tests and test documentation shall comply with the IFC and the Denver Amendments to the IFC.
6. Raceway, boxes, and Conductor Inspection by DEN: Contractor shall complete construction and installation of all raceways, boxes, devices, conductors, contactors and connectors in accordance with Construction Documents. Installation of all equipment or devices monitored or controlled by the Fire Alarm System shall be complete except for connections. All pull boxes, device boxes and equipment boxes shall be left open for inspection. Conductors shall be installed and labeled in accordance with Contract Documents. Conductors shall be tested prior to attachment of devices in compliance with NFPA 72, including but not limited to:

    a. Record of all testing.
    b. Resistance.
    c. Ground faults.
    d. Short circuit fault.
    e. Stray Voltage.

7. Fire Alarm System Device(s) Installation: Installation of all equipment or devices monitored or controlled by the Fire Alarm System shall be complete and operational at this time, except for connection to the existing building Fire Alarm System. Fire Alarm devices and control equipment shall be installed and labeled per Contract Documents, including device numbers per approved Fire Alarm shop drawings. All devices shall be dust protected except during testing.
8. The Contractor shall be responsible for providing all equipment necessary to test the system for all tests including the following:

    a. Magnets.
    b. Audio sound pressure meter.
    c. Intelligibility meter.
    d. Canned smoke – Multiple cans with test device to reach smoke detectors.

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e. Communication source (radios and/or cell phones).
f. Ladders.
g. Air velocity meter.

9. Pretest / System Connection: Building finishes shall be complete. A pre-test of the entire system shall be conducted by the Contractor and manufacturer. Any deficiencies found shall be corrected prior to the Demonstration Test. The Contractor shall be responsible for all costs associated with damage to the existing Fire Alarm system due to incorrect wiring or installation of the new system. The Contractor shall provide all equipment required for testing. The Contractor shall perform all testing in accordance with NFPA and published manufacturer recommendations.

   a. Request for Pretest / Connection: The Contractor shall submit a written request for pre-testing five (5) working days in advance of the requested pretest time. Pre-testing time may be required during night time, and shall not be performed during City Holidays. The Contractor shall include with the Pre-test request the following:

      1) Completely executed Record of Completion.
      2) Certification that the system has been installed in compliance with Contract Documents and NFPA 72. Certification shall comply with DFD requirements and NFPA 72.
      3) Written verification by the Fire Alarm System Programmer the Programming is complete and ready for testing.
      4) One legible copy of Fire Alarm Shop record drawings.
      5) One legible copy of Manufacturer’s testing procedures for each device.
      6) List of each Fire Alarm Device Installed including address if provided on shop drawings.

10. System Connection and Testing:

    a. The Contractor shall be responsible for coordinating and conducting the Demonstration Test in the presence of the Engineer and DEN Project Manager.

11. All systems and devices monitored and or controlled by the Fire Alarm System shall be complete, tested and operational. Testing shall include but not be limited to:

    a. The functional operation of each re-settable initiating device (manual stations, detectors, etc.) and circuit.
    b. The functional operation of all alarm devices and circuits.
    c. The functional operation of each monitored device circuit.
    d. The functional operation of each control circuit, including fan controls.
    e. The supervision functions of each initiating, indicating, monitoring, control and supply circuit.

    f. One-half of all tests shall be performed on battery standby power when a

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new FACP or Transponder Panel is provided.

g. If unsatisfactory results occur during the Demonstration Test, the Contractor shall be responsible for any and all additional charges incurred by the Owner with respect to corrective action, including but not limited to test monitoring and engineering services during the time it takes to obtain Final Acceptance by the DEN Project Manager.

h. Final Acceptance by the DEN Project Manager means that the fire alarm and emergency communications system is:

1) Completely operational and in conformance with this specification.
2) In conformance with applicable codes and standards
3) All documentation has been submitted as required by these specifications.
4) All training as required by these specifications has been completed to the satisfaction of the Owner's Designated Representative.

i. Alarm, supervisory and trouble annunciation through the AES system.

j. Functional building hardware and equipment testing: Each building device or equipment monitored by the Fire Alarm System shall be operated so as to cause an alarm or trouble on the Fire Alarm System. Each building device or equipment activated and/or controlled by the Fire Alarm System shall be operated through activation by the Fire Alarm System and or/Fire Alarm devices.

k. Sequence Testing: After testing of devices and equipment verifies correct device operation, fire alarm sequence testing shall proceed. Each sequence of operation shall be tested, including sequences linked with activation of devices in adjacent areas that command operation or activation of devices in the new area of construction. At the completion of successful testing, the Contractor shall submit certification in compliance with NFPA 72 that the system is functional and operational.

12. Smoke Testing: The smoke control systems will require testing at the DFD Proof Test to verify the sequence of operation and proper system control. The Contractor shall perform smoke testing during sequencing tests if the Contractor's scope includes work that modifies the nature of ceiling openings, ceiling configuration, draft stops, supply HVAC, smoke control fans, walls above ceilings, etc. Ceiling/area modifications and storefront modifications require smoke testing during the Proof Test.

a. Request for Code Agency inspection: After successful testing, the Contractor shall contact the Denver Fire Department.

b. The programmer shall certify in writing the following:

1) Each device is correctly labeled in the field and on the CGP.
2) All wires are correctly labeled.
3) All boxes are correctly labeled indicating circuits.
4) Program sequence is correct and compliant with Code requirements.
5) Verify Contractor device and conduit record documents
6) All sequences driven by the programming sequence have been checked and are without error.

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13. DFD Proof Testing: All system alterations and additions shall be tested and accepted by the Denver Building Department and the Denver Fire Department. The Contractor is responsible for all fees for testing. Proof testing of installations or additions to the fire alarm systems in public areas requires night testing to minimize operational disruptions. Proof Testing shall not be performed during City Holidays.

    a. DFD Notification: The Contractor (after successful pre-testing is completed) shall provide a written notice to the Denver Fire Department for testing five days in advance of the time and date requested for the test date. The Contractor shall copy the DEN Project Manager concurrently. The request for testing shall include itemization of devices and systems to be tested in the format as required by the Denver Fire Department. Night testing and/or re-testing by the Denver Fire Department requires an additional fee established by the Denver Fire Department
    b. The Contractor responsibilities at the time of the Proof test: The Contractor shall make available the Stamped set of drawings with changes approved by the Denver Fire Department Fire Prevention Engineer. The Contractor shall provide the following:

        1) Documentation:

            a) Original # 3 & # 3A permits including building department stamped prints.
            b) One copy of marked up record drawings installed in Building Fire Command Room.
            c) Contractor’s written certification the system installation complies with NFPA requirements (i.e, Record of Completion).

        2) The Contractor representatives for each trade shall be available at the test and shall activate and monitor devices for the test. Contractor shall be prepared to modify or repair system(s) installation at time of the Proof Test if directed by the DFD. Testing shall include all devices installed and shall include activation/shut down of equipment controlled or monitored by the installation (i.e. fill of dry sprinkler systems, smoke fans, fire doors, etc.).

14. Review of items listed in paragraph 2 above shall be completed. Incomplete preparation and/or incomplete submittals noted in paragraph 2 at the time of the Proof Test may be cause for DFD cancellation of the Proof Test. The Contractor shall pay all fees for retesting.

    a. Two Denver Fire Inspectors shall observe and direct the proof test and sign off the 3A PERMIT and FIRE ALARM AND SPRINKLER INSPECTION REPORT subject to acceptance.
    b. The Contractor shall provide a completed and signed copy of the NFPA 72 Record of Completion Form after the Demonstration Test has been completed.

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3.8 DEMONSTRATION AND TRAINING

A. General:

1. Provide the services of SimplexGrinnell to demonstrate the system and train Owner's maintenance personnel as specified below.

   a. Train Owner's technicians in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintenance of the system. This training shall be provided for up to 12 owner’s technicians for minimum of two (2) 2-hour training sessions as dictated by the DEN Project Manager.
   b. Schedule training with Owner, through DEN Project Manager, with at least seven (7) days advance notice.

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. Reference Allowances in the Contract Bid form. The cost for all other work described in this section shall be included in the Lump Sum Contract price.

END OF SECTION 283100

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EXHIBIT J

Contract Drawings

Incorporated by Reference
As Found in File #20200060 at the Denver
Office of the Clerk and Recorder

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EXHIBIT K

PROJECT MANUAL

Concourse A & C Pre-Conditioned Air Re-Life

201951778

PART I

PROJECT REQUIREMENTS

Issued for Bid February 21, 2020

CITY & COUNTY OF DENVER
DEPARTMENT OF AVIATION

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CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION
DENVER INTERNATIONAL AIRPORT
CONCOURSE A & C PRE-CONDITIONED AIR RE-LIFE
NO. 201951778

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CITY AND COUNTY OF DENVER
NOTICE OF INVITATION FOR BIDS
CONTRACT NO. 201951778
Concourse A & C Pre-Conditioned Air Re-Life

The Department of Aviation, City and County of Denver, has issued an Invitation for Bids for the construction project named above. Complete contract documents, including specifications, are available on the DEN Contract Procurement website at:
http://business.flydenver.com/bizops/bids.asp.

SEALED BIDS will be due, and must be time stamped, no later than **1:00 PM Local Time, March 26, 2020**, delivered in the triple wide trailer, located within the DEN South Campus at 7128 North Trussville Street, Unit A, Denver, CO 80249 (F.K.A. 27301 E. 71st Ave, Unit #2). Immediately after receipt of the bids a public bid opening will commence. Any bids to be submitted more than two hours prior to Bid Opening must be submitted at the office of Business Management Services, attention Tony Deconinck, Room 8810, Airport Office Building (AOB), Denver International Airport, 8500 Peña Blvd., Denver, CO 80249-6340.

GENERAL STATEMENT OF WORK

Provide the full replacement of mechanical systems and supporting equipment on Concourses A and C that supply the pre-conditioned air units. This scope includes the phased replacement of existing floor slabs with structural slabs to mitigate floor heaving in each plant. In addition to these improvements, walls will be relocated in the Concourse A plant in order to provide additional space for future ice storage. The project will be phased to coordinate with the opening of the concourse expansions on Concourses A and C.

PREQUALIFICATION

Each bidder must be pre-qualified in the category of 2B General Building – Occupied Buildings, OR 2F Mechanical at the $15,000,000 monetary level, in accordance with the City's Rules and Regulations Governing Prequalification of Contractors.

Each bidder must have submitted a prequalification application a minimum of ten (10) calendar days prior to the bid opening date. Prequalification applications must be submitted to the Department of Public Works, Prequalification Section, Dept. 614, 201 West Colfax Avenue, Denver, CO 80202. To view the Rules and Regulations and to obtain a prequalification application, please visit our website at www.denvergov.org/prequalification, or call (720) 865-2539 for prequalification.

To view the Rules and Regulations and to obtain a prequalification application, please visit our website at www.denvergov.org/prequalification or call 720-865-2539 for prequalification.

MANDATORY PRE-BID CONFERENCE AND MANDATORY GUIDED SITE TOUR

A mandatory Pre-Bid Conference will be held at 2:00 PM, March 11, 2020, in the City Conference

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Room at Denver International Airport. The City Conference Room is located on the northwest side of Level 6 of Jeppesen Terminal. The address of Denver International Airport is 8500 Pena Boulevard, Denver, CO 80249. At this conference, City representatives will explain the opportunity and answer questions regarding this project.

Immediately following the pre-bid conference, a mandatory site tour will be conducted. This is to allow all proposed bidders to view the facility before submitting bids. *Due to the nature of the areas to be visited and the security concerns of the airport, DEN will limit participation of the site-tour to no greater than two (2) members from each company.* Each member will need to be listed in a pre-proposal site-tour list to participate.

Because areas of the airport require pre-authorized clearance, all tour participants must pre-register. It is anticipated that this tour will last approximately 2 hours. **The cut-off time/date to pre-register for this tour is 2:00 PM on March 2, 2020**. Everyone attending this site tour is required to pre-register for the tour by completing the following survey at: https://www.surveymonkey.com/r/GYDDWPH.

Anyone who has not pre-registered for the site tour will not be allowed to attend.

QUESTIONS

Any questions must be submitted in writing by email to contract.procurement@flydenver.com, must have the words "Request for Clarification" and "Concourse A & C Pre-Conditioned Air Re-Life, 201951778" in the email subject line, and must be received no later than March 19, 2020, at 2:00 p.m.

MINORITY BUSINESS ENTERPRISE PARTICIPATION

Construction, reconstruction and remodeling contracts made and entered into by the City and County of Denver are subject to Article III, Divisions 1 and 3 of Chapter 28 of the Denver Revised Municipal Code, (Sections 28-31 to 28-36 and 28-52 to 28-90 D.R.M.C) and all Minority and Woman Business Enterprise and Equal Employment Opportunity Rules and Regulations adopted by the Director of the Division of Small Business Opportunity. Article III, Division 3 of Chapter 28 of the D.R.M.C. directs the Director of the Division of Small Business Opportunity to establish a project goal for expenditures on construction, reconstruction, and remodeling work contracted by the City and County of Denver. The specific goal for this project is:

15% Minority and Woman Business Enterprise (M/WBE) Participation

Project goals must be met with certified participants as set forth in Section 28-60, D.R.M.C. or through the demonstration of a sufficient good faith effort under Section 28-62 D.R.M.C. For compliance with good faith requirements under Section 28-62(b), the M/WBE percentage solicitation level required for this project is 100%.

The Director of the Division of Small Business Opportunity urges all participants in City construction, reconstruction and remodeling projects to assist in achieving these goals.

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CITY, AIRPORT AND PROJECT OVERVIEW

The values of equity, diversity, inclusivity, and sustainability are inherent to Denver's strategy to develop and maintain prosperous communities. Consequently, these values are imbedded into all of Denver's procurement processes to ensure competitive procurement that offers equitable opportunities for all potential proposers, including greater contracted participation for minority, women-owned, and small businesses to ensure Denver's long-term economic, social, and environmental health. It is the City's expectation that all successful bidders demonstrate their commitment to City values through their procurement responses and post contract and/or lease activities.

Each procurement opportunity is to be approached with ethical and honest behavior. The City will solicit, evaluate, and award contracts based upon the bidder's approach, proven experience, ability to perform work, costs, and pricing.

The City's values may be demonstrated through, but are not limited to:

- Workforce expansion;
- Utilization of minority, women-owned, and small business community separate from required certified goals; and
- Environmental sustainability.

In accordance with procedures described herein, you are hereby invited to submit a bid for the subject project, which is described in the Scope of Work incorporated herein. The work under this Contract is anticipated to start on or about May 2020 and has a scheduled duration of approximately two years. The bid must be prepared and submitted in accordance with the requirements and procedures contained in this IFB document and the City's, including DEN's, ordinances, rules, policies, and procedures. Compliance with these requirements by the bidder is mandatory and is a condition of responsiveness. Any failure to satisfy these requirements will be a sufficient basis for the City and County of Denver's Department of Aviation, also known as Denver International Airport, (DEN or City) to disqualify the bid. The City shall not be liable for any of the bidder's expenses associated with its preparation of the bid or DEN's consideration of it. The bidder, if selected, shall not include any such expenses as part of its fee for performing the Scope of Work.

MISCELLANEOUS

As its best interests may appear, the City and County of Denver reserves the right to reject any or all bids and to waive informalities in bids.

The work under the Contract is subject to minimum wage rates established by the City and County of Denver Career Service Board.

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Checklist: Required Submittal forms

For convenience, this is a list of the forms required at bid submittal for this project:

- Bid Forms
  - Bid Letter, filled out completely and addressing all addenda
  - Schedule of Prices & Quantities

- Bid Data Forms
  - Information About Contractor
  - List of Proposed Subcontractors Which Are Not MWBE Subcontractors
  - EEO Questionnaire
  - Equal Opportunity Report Statement
  - Certification of Non-Segregated Facilities

- Diversity and Inclusivity in City Solicitations (filled out online, then printed and included with the bid)

- W-9

- DSBO Forms
  - Commitment to MWBE Participation
  - List of Proposed MWBE Bidders, Subcontractors, Suppliers (Manufacturers) or Brokers

- Executed Bid Bond

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INSTRUCTION TO BIDDERS
CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION

IB-1 INSTRUCTIONS TO BIDDERS

These Instructions to Bidders are a part of the contract documents and are intended to serve as a guide to Bidders. They are general in nature and may be amended or supplemented as needed to support any one specific invitation to bid. Each Bidder shall prepare its bid in strict compliance with all requirements of the contract documents and by careful application of these instructions.

IB-2 BIDDING

These contract documents contain Bid Forms and Bid Data Forms. The Bidder must complete these Bid Forms and submit them as its bid.

Each bid must be enclosed in a sealed envelope, addressed to the Chief Executive Officer (CEO), showing on the face of the envelope the name of the Bidder, the project number, and descriptive title of the work for which the offer is made. The Notice of Invitation for Bids identifies where and when the bid must be delivered.

Addenda to the contract documents will be issued by publication in their entirety on the DEN Contract Procurement Website, http://business.flydenver.com/bizops/bids.asp, from which each addendum document may be downloaded by planholders. Such addenda may include replacements for or additions to some or all of the pages of the Bid Forms, and all Bid Form pages added by addendum shall be submitted with the Bid Forms. Either a complete addendum or a notice of its issuance will be posted on the DEN Contract Procurement Website. Prior to submitting bids, Bidders shall read the DEN Contract Procurement website to confirm that they have received all addenda.

If Sensitive Security Information ("SSI") will be provided to potential Bidders prior to award of the Contract, each potential Bidder shall be required to comply with Department of Aviation, Standard Policies and Procedures No. 6003, "Contractor Protection of Sensitive Security Information," or its successor. A copy of this Policies and Procedures document will be provided upon request by the Department of Aviation, Contract Services Office.

Each Bidder shall submit the following, completed and executed in accordance with the contract documents:

(1) the Bid Forms, including any additional forms required by any addendum;

(2) the Bidder's Bid Bond or Bid Guarantee in conformance with IB-13; and

(3) the Bidder/Contractor Disclosure Form described in IB-29 and included with the Bid Forms, unless the Bidder has a current disclosure form on file with the City Clerk.

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IB-3 COMPLETING AND SIGNING BID FORMS

The Bidder must complete the Bid Forms by legibly writing or printing in ink, words or figures, or both if required, all the Bidder's offered prices for performing the work. All blank spaces which require a response of the Bidder must be properly filled in. In filling out the Bid Forms, the Bidder should avoid making changes to the extent possible, but, if changes are necessary, any interlineation, white outs, or erasures should be initialed.

For any contracts containing unit prices, the Bidder shall specify in the Bid Forms a unit price for each item for which a quantity is given and shall write in figures the products of the respective unit prices and quantities in the "Amount" column provided for that purpose.

Each Bidder must sign the Bid Forms and give the Bidder's current business address and contact information as noted. If an individual, the signature must be of the individual offering the bid; if a partnership, the signature must be that of a general partner; and if a joint venture, by each joint venture participant in their individual capacity as a corporation, partnership, or individual; if a corporation, both the president or a vice president and the secretary must sign and the seal of the corporation must be affixed. Signatures of other persons may be acceptable if the bid contains evidence satisfactory to the CEO to prove that the other persons are authorized to bind the Bidder.

IB-4 UNACCEPTABLE BIDS

The City will not accept Bids from Bidders in arrears to the City upon debt or contract, or which are defaulters (as surety or otherwise) upon any obligation to the City, or that are deemed irresponsible or unreliable by the CEO. A history or pattern of litigation against the City and County of Denver by any Bidder, proposed subcontractor, interested party, or any person, firm, or corporation affiliated with any Bidder, among other items, will be considered by the CEO in determining the responsibility and reliability of Bidders. Bidders may be required to submit satisfactory evidence that they have a practical knowledge of the particular work bid upon and that they have the necessary financial resources to complete the proposed work.

IB-5 ONLY ONE BID ACCEPTED

The City will accept only one bid for the same work from any one Bidder. This includes Bids that may be submitted under different names by one firm or corporation. Evidence of collusion among Bidders shall be grounds for exclusion of any Bidder who is a participant in any such collusion.

IB-6 OPENING OF BIDS

Bidders are invited to be present at the bid opening which shall occur in the triple wide trailer, located within the DEN South Campus at 7128 North Trussville Street, Unit A, Denver, CO 80249 (F.K.A. 27301 E. 71st Ave, Unit #2) on the date set forth in the Notice of Invitation for Bids.

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IB-7 CONSIDERATION OF BIDS

After the bids are opened and read and any discrepancies have been reviewed, bids will be compared based on the Total Contract Bid Amount written on page B-1 of the Bid Letter.

If a discrepancy exists between a price or amount written in words and the price or amount written in figures, the price or amount written in words shall govern, except that in the case where a price or amount shown in figures has been crossed out and replaced with a new, legible, initialed figure, the initialed figure shall govern.

Any bid discrepancies which the City corrects in accordance with the general rules described above shall be corrected with the understanding that the Apparent Low Bidder waives any claims against the City because of the Bidder's mistakes in its bid.
w
The City reserves the right to waive informalities, to reject any and all bids, and to advertise for new bids where it is in the best interest of the City. The City also reserves the right to negotiate terms of the contract.

DEN reserves the right to cancel this IFB at any time, without penalty, and to reject any and all bids; with or without cause. All bids shall be considered by DEN as an invitation to negotiate a contract for the work. DEN also reserves the right to waive any informality or irregularity in any bid it receives and to be the sole judge of the merits of the bid it receives. Minor informalities are matters of form rather than substance evident from the response or insignificant mistakes that can be waived or corrected without prejudice to other proposers; that is, the effect on price, quantity, quality, delivery, or contractual conditions is negligible. The Contract Administrator may waive such informalities or allow any Bidder to correct them depending on which is in the best interest of DEN. Bidders will be notified of the allotted time to correct the minor informality by DEN's Contract Administrator. Failure to correct the minor informality by the Bidder may result in their bid being deemed non-responsive.

IB-8 INFORMAL AND UNBALANCED BIDS

Bids shall be considered informal and may be rejected for the following reasons:

(a) If the bid is on a form other than the Bid Forms furnished by the City, or if the form is altered or any part thereof is detached.

(b) If there are unauthorized additions, conditional or alternate bids, or irregularities of any kind which may tend to make the bid incomplete, indefinite, or ambiguous.

(c) If the Bidder fails to acknowledge in the bid receipt of any or all addenda current on the date of opening of bids.

(d) If the bid does not contain a unit price or lump sum amount for each item listed except

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in the case of authorized alternative items.

(e) If there is an interlineation, white out, or erasure in the Bid Forms.

(f) If the bid is unbalanced so that (1) each pay item does not reasonably carry its own proportion of cost, or (2) any pay item contains an inadequate or unreasonable price.

IB-9 BASIS FOR SELECTING THE APPARENT LOW BIDDER

The selection of the Apparent Low Bidder will be made on the basis of the lowest responsive bid by a qualified Bidder whose bid complies with all of the requirements prescribed herein. The lowest Bidder shall be determined by the Total Base Bid Amount. This selection shall be subject to the approval of such resulting contract in accordance with the Charter and ordinances of the City and County of Denver.

If add alternates are listed in the Bid Documents, the Apparent Low Bidder will be chosen based solely on the lowest responsive Total Base Bid Amount.

IB-10 NOTICE TO APPARENT LOW BIDDER – EXECUTION OF CONTRACT

The Apparent Low Bidder will be given written notice of such status on the form included in the Bid Documents within ninety (90) days from the date of opening of bids.

The Apparent Low Bidder should execute the contract and return it to the City along with the required bonds and insurance forms within ten (10) calendar days from and including the date of the Notice to Apparent Low Bidder. When the executed contract and the required bonds and insurance certificates are received, approval for the City to contract with the Apparent Low Bidder shall be sought in accordance with the Charter of the City and County of Denver. Such notice shall not create any rights in the Apparent Low Bidder to any contract with the City.

IB-11 CONFORMED TECHNICAL SPECIFICATIONS AND CONTRACT DOCUMENTS

The Bidder understands that the City may elect, in its sole discretion, to deliver either one of the contract documents described below for execution.

(a) A bound document containing the original Bid Documents and all of the prebid addenda, or

(b) A bound document containing Part I of the original Bid Documents, the portions of the addenda which apply to Part I, and a single conformed set of Technical Specifications and contract documents which are produced by posting or otherwise incorporating in Part II of the original Bid Documents all of the changes to Part II which are described in the prebid addenda. If the City elects to prepare a conformed set of Technical Specifications and Contract Drawings, the following provision shall

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be incorporated in the Conformed Technical Specifications after the first page of its Table of Contents:

The Technical Specifications and the Contract Drawings which were included in the Bid Documents, hereinafter referred to as the "Bid Document Specifications and Drawings," have been conformed by the City. The conformed Technical Specifications and Contract Drawings were prepared by posting or otherwise incorporating the changes noted in the prebid addenda into the Bid Document Specifications and Drawings to form a single set of construction documents. This set of construction documents is attached hereto and is hereinafter referred to in this document as the "Issued for Construction Documents."

The City's objective in preparing the Issued for Construction Documents is to produce a single set of documents which the Contractor and City will use during construction and which will facilitate the administration of the Contract. The city, however, recognizes that discrepancies between the Issued for Construction Documents and the prebid addenda could occur. Therefore, the Contractor and City agree that both parties shall have 90 days after a fully executed contract is delivered to the Contractor to identify any such discrepancies.

If the Contractor identifies any discrepancy, it shall describe it in a written notice delivered to the City's Project Manager within the 90-day period. If the City agrees that a discrepancy exists, the City shall correct the Issued for Construction Documents in accordance with the written notice to assure that the Issued for Construction Documents accurately reflect and are consistent with the Bid Document Specifications and Drawings and changes thereto reflected in the prebid addenda.

If the City identifies a discrepancy, it shall describe it in a written notice delivered to the Contractor's Superintendent within the above-described 90-day period. The City shall, thereafter, correct the Issued for Construction Documents in accordance with the written notice. If the Contractor disagrees with any City proposed correction or any City refusal to accept a Contractor proposed correction, the Contractor shall have the right to submit a Contractor Change Request and request a Change order in accordance with General Condition 1103.

During the 90-day period, the Bid Document Specifications and Drawings and the prebid addenda shall be part of the contract documents and are incorporated herein by this reference. After the 90-day period has elapsed, the parties (1) agree that the Issued for Construction Documents, as corrected pursuant to this provision, accurately reflect all of the changes to the Bid Document Specifications and Drawings contained in the addenda, and (2) agree that the Bid Document Specifications and Drawings and the portions of the prebid addenda which pertain thereto shall no longer be considered contract documents.

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IB-12 QUANTITIES IN THE BID FORM ENTITLED SCHEDULE OF PRICES AND QUANTITIES (PART 2 OF THE BID FORMS)

Except for items designated as Lump Sum, the quantities appearing in the Bid Forms are approximate only and are included for the purpose of comparing of bids.

Payment to the Contractor will be based on the actual quantities of work performed, measured, and accepted or materials furnished in accordance with the contract documents.

Any of the estimated quantities of work and materials shown in the Bid Forms may each be increased, decreased, or omitted as provided in the General Conditions, Special Conditions, or Technical Specifications.

IB-13 BID GUARANTEE; BONDS; INSURANCE

As a guarantee of good faith on the part of the Bidder, each Bid must be accompanied by a Bid guarantee consisting of either a certified or cashier's check made payable without condition to the order of the City and County of Denver or a bid bond written by an approved corporation surety in favor of the City and County of Denver. If the Bid of a Bidder is acceptable and the Bidder is notified by the CEO that it is considered to be the Apparent Low Bidder and said Bidder fails to (1) execute a contract in the form prescribed, (2) furnish the payment and performance bonds described in Title 15 of the General Conditions, (3) furnish the required evidence of insurance described in Title 16 of the General Conditions or in the Special Conditions, or (4) satisfy any other condition precedent to contract execution within its power within five (5) working days after such notice is made by the City, said bid guarantee shall be forfeited to the City as liquidated damages and not as a penalty. The bid guarantee shall be in the amount of five percent (5%) of the Total Contract Bid Amount written in the Bid Letter of the Bid Forms. A Bid Bond form for execution by the Bidder is supplied with each set of contract documents. IF A BID BOND IS USED, IT MUST BE THE FORM OF BID BOND SUPPLIED WITH THE CONTRACT DOCUMENTS.

IB-14 RETURN OF BID GUARANTEE

As soon as bid prices have been compared, bid guarantees of all except the three lowest Bidders will be returned. When the Apparent Low Bidder executes the contract and delivers to the City satisfactory performance and payment bonds and required insurance documentation, and any other conditions precedent to contract execution by the City have been satisfied, including, where applicable, City Council contract approval, the bid guarantees of the three lowest Bidders shall be returned to them.

IB-15 CONTRACT PROCUREMENT WEBSITE

It shall be conclusively presumed that the Bidder did, before submitting a bid, read all addenda, posted decisions, and other information items relevant to the Bid which appeared

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on the DEN Contract Procurement website at http://business.flydenver.com/bizops/bids.asp.

IB-16 SITE INSPECTION AND INVESTIGATIONS

Prior to submitting a bid, the Bidder shall inspect the work site and its surroundings. A site visit may be undertaken at the time of the pre-bid conference if indicated. Requests for additional site visits must be made at least ten (10) calendar days prior to the bid opening and such visits must be requested in a letter sent to email to contract.procurement@flydenver.com. For purposes of the contract, it shall be conclusively presumed that the Bidder has made a thorough inspection of the site and has waived the right to later claim extra payment or time extensions for conditions which would have been evident during an inspection.

Drawings and specifications, defining the work to be done, were prepared on the basis of interpretation by design professionals of information derived from investigations of the work site and site condition data provided by the City. Such information and data are subject to sampling errors, and the interpretation of the information and data depends to a degree on the judgment of the design professional. In view of this, the Bidder is invited to make additional investigations as the Bidder's judgment dictates the need for such investigations.

Because the bid information cannot be guaranteed, the Contractor shall have assumed the risks attendant to successful performance of the work except for the risk of encountering differing site conditions which are defined in the General Conditions and shall never make claim for additional payments or time extensions on the grounds that the nature or amount of work to be done was not understood by the Bidder at the time of bidding.

IB-17 INTERPRETATION OF BID DOCUMENTS

During the Bid period, Bidder shall request, in writing, clarification or interpretation of any apparent errors or omissions in the contract documents, any apparent inconsistencies between different provisions of the contract documents, or any other point in the contract documents which the Bidder believes requires clarification or interpretation by the City. Any such request must be submitted in writing by email to contract.procurement@flydenver.com, must have the words "Request for Clarification" and "Concourse A & C Pre-Conditioned Air Re-Life, 201951778" in the email subject line, and must be received no later than the deadline indicated in these bid documents. For purposes of the contract, it shall be conclusively presumed that prior to bidding, the Bidder requested clarification or interpretation of any apparent errors, inconsistencies, or other point in the contract documents believed to require clarification or interpretation, and has waived the right to later claim extra payment or time extensions on account of any such error, omission, inconsistency, or other matter in the contract documents.

Information about any interpretation or clarification made by the City in response to such request will be posted on the DEN Contract Procurement website, http://business.flydenver.com/bizops/bids.asp. It shall be the Bidder's responsibility to

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ensure it has reviewed all such interpretations or clarifications. After Bids are opened, all Bidders must abide by the decision of the CEO or his authorized representative as to the interpretation or clarification. If the CEO or his authorized representative determines that his decision or interpretation requires that an addendum to the Bid documents be issued, such addendum will be posted on the DEN Contract Procurement website. It shall be the Bidder's responsibility to ensure it has received all such addenda, and each Bidder must acknowledge receipt of all addenda on the Bid Forms when it submits its Bid.

The City shall not be bound by and the Bidder shall not rely on any oral interpretation or clarification of the Bid Documents.

IB-18 MATERIALS AND SUBSTITUTIONS

It is often convenient and practical to specify materials and equipment to be incorporated into the work by a proprietary name or by the name of its manufacturer. When so specified and further qualified by the phrases "or equal" or "or equivalent," it shall be understood that such specification is not intended to limit the material and equipment selection process. Rather, the specification is intended to indicate a standard of quality and capability which will be accepted. However, all Bidders desiring to use materials other than the specified material must obtain the written approval of the Project Manager. Any such request must be submitted in writing by email to contract.procurement@flydenver.com, must have the words "Request for Substitution" and "Concourse A & C Pre-Conditioned Air Re-Life, 201951778" in the email subject line, and must be received no later than ten (10) calendar days before the date and time set for opening of bids so that all such approvals will be included in addenda to ensure full and complete disclosure to all potential Bidders of all approved equal or equivalent materials. All requests for approval of equal or equivalent material shall contain adequate technical data to clearly demonstrate equivalency. Incomplete submittals will not be reviewed. Requests must be submitted on the attached form titled "Request for 'or equal' Approval." Requests containing inadequate or incomplete information will not be considered.

If the Bidder is awarded the contract and elects to use an "OR EQUAL" which has been added by addendum, the Bidder shall be deemed to have warranted that;

(a) the use of the "OR EQUAL" fulfills the specification requirements contained in the contract documents.

(b) the installation of the "OR EQUAL" will not impact the spatial requirements for the Work or the scheduling of work performed by the City or other contractors.

Additionally, the Bidder agrees that it shall modify any building system(s) (HVAC, structural, electrical, etc.) impacted by the use of an "OR EQUAL" at no cost to the City or other contractors under contract with the City and shall make no claims for delay or disruption arising out of such modification.

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IB-19 WITHDRAWAL OF BID

A Bidder may withdraw its Bid at any time prior to the time for opening of bids set forth in the Notice of Invitation for Bids by making written request to the CEO. After the expiration of the bid period, no bid can be withdrawn for one hundred twenty (120) calendar days after the date bids are opened or until after a contract for the work described in these Bid Documents is fully executed by the City, whichever date is earlier.

Such a request must be signed by persons authorized to bind the Bidder as defined in IB-3, "Completing and Signing Bid Forms."

IB-20 SUBCONTRACTOR LISTS IN BID

The Bidder shall, on the forms included in the Bid Forms, identify each element of the work which the Bidder plans to subcontract, provide an estimate of the total cost to perform each element, and include the name and address of the proposed subcontractor.

IB-21 PERMIT FEES

The Contractor agrees to pay the permit fees associated with the construction of this project described in General Condition 317 and in the Special Conditions and Technical Specifications.

IB-22 TAXES

1. General. Bidders are referred to the General Conditions, G.C. 323, as to taxes to which they may be subject in performing the Work under this contract, including but not limited to sales and use taxes and the Denver Occupational Privilege Tax. The following instructions are to be considered along with the General Conditions and not in lieu of them.

2. Sales and Use Tax. Construction and building materials sold to contractors and subcontractors for use on structures, roads, streets, highways, and other public works owned by the City and County of Denver at Denver International Airport are exempt from state, RTD, and Cultural Facilities District sales and use taxes. However, such materials will be subject to sales and use taxes imposed by the City and County of Denver.

3. Exemption Certificates – Sales and Use Tax. It is responsibility of the Contractor and its subcontractors to apply to the Colorado Department of Revenue ("CDOR") for a certificate, or certificates, of exemption indicating that their purchase of construction or building materials is for a public project, and to deliver to the City copies of such applications as soon as possible after approval by the CDOR. Bidders shall not include in their bid amounts the exempt State, RTD, and Cultural Facilities District Sales and Use Taxes.

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4. Denver Occupational Privilege Tax. Any employee working for a contractor or a subcontractor who earns over $500 working in Denver during a calendar month is subject to the payment of the Employee Occupational Privilege Tax. The Contractor and any subcontractor must pay the Business Occupational Privilege Tax for each of its employees who are subject to such tax.

IB-23 NONDISCRIMINATION IN THE AWARD OF CITY CONTRACTS

It is the policy of the City and County of Denver to prohibit discrimination in the award of construction contracts and subcontracts for public improvements. Further, the City and County of Denver encourages contractors to utilize minority and women owned businesses and to divide the construction work into economically feasible units or segments to allow the most opportunity for subcontracting.

IB-24 MINORITY AND WOMEN BUSINESS ENTERPRISE (MWBE) REQUIREMENTS

Article III, Divisions 1 and 3 of Chapter 28, Denver Revised Municipal Code (D.R.M.C.), designated as Sections 28-31 – 28-36 and 28-52 – 28-90 D.R.M.C. and referred to in these Bid Documents as the "MWBE Ordinance" and any Rules or Regulations promulgated pursuant thereto apply to this Project and are incorporated into these Bid Documents by reference. Generally, the MWBE Ordinance provides for the adoption of a good faith goals program, to be administered by the Division of Small Business Opportunity (DSBO), devised to provide increased bidding opportunities for Minority and Woman Business Enterprises (MWBEs). As such, each bidder must comply with the terms and conditions of the MWBE Ordinance in making its bid and, if awarded the Contract, in performing all Work thereunder. A bidder's failure to comply with the MWBE Ordinance, any Rules or Regulations promulgated pursuant thereto, or any additional requirement contained herein shall render the bid non-responsive and shall constitute cause for rejection. Failure by the contractor awarded the contract to comply with MWBE Ordinance requirements during the performance of the contract is a material breach of the contract, which may result in the in the imposition of sanctions on the Contractor, as deemed appropriate by DSBO. Copies of the MWBE Ordinance and its accompanying Rules and Regulations are available for the use and review of bidders from DSBO. In order to comply with the bid requirements of the MWBE Ordinance, a bidder shall either meet the established project goal or, in the alternative, demonstrate that the bidder has made sufficient good faith efforts to meet the goal in accordance with the MWBE Ordinance.

Meeting Established Goal

In preparing a bid to meet the established Project goal of 15% MWBE, bidders should consider the following instructions relating to compliance with the MWBE Ordinance:

1. Under the MWBE Ordinance, the Director of DSBO ("Director") is directed to establish project goals for expenditures on construction, reconstruction, and remodeling work performed for the City and County of Denver. The specific goal for this project is stated in the Notice of Invitation for Bids bound herein.

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2. In preparing its bid, each bidder shall list on the Bid Form pages entitled "List of Proposed MWBE Bidders, Subcontractors, Suppliers, Manufacturers, Manufacturers' Representatives or Brokers" the name, address, work description/supply, committed level of participation and other required information for each MWBE of any tier which the bidder intends to use in performing the work on this Project. **Only the MWBEs identified and the precise levels of participation listed for each on the Bid Form page, at the time of bid opening, will be considered in determining whether the bidder has met the designated participation goal. Additional, revised or corrected participation submitted after bid opening will not be considered.** MWBE bidders may count self-performance or joint venture activity in meeting the MWBE project goal, but only for the scope of work performed as a commercially useful function and at a percentage level the MWBE will be performing itself.

3. Any agreement between a bidder or proposer and an MWBE in which the bidder or proposer requires that the MWBE not provide subcontracting quotations to other bidders or proposers is prohibited and shall render a bidder's bid or proposer's proposal nonresponsive. D.R.M.C. 28-63(f)

4. If a bidder/proposer is participating in a joint venture with a certified MWBE firm, complete the Joint Venture Eligibility Form and Joint Venture Affidavit contained in this bid document/RFP. Submit the aforementioned forms with the firm's Joint Venture Agreement, to the DSBO Director, **at least 10 working days prior to the proposal submittal.** The Joint Venture must be approved prior to the bid opening or proposal submittal by the DSBO Director. Approval by the DSBO Director includes determining the amount the Joint Venture will count towards meeting the project goal.

5. All MWBEs listed on the Bid Form must be properly certified by the City on or before the date bids are opened in order to count towards meeting the designated goal. DSBO maintains an MWBE Directory ("Directory"), which is a current listing of MWBEs that have been certified by the City. A copy of the DSBO Directory is located at DSBO web site at https://www.denvergov.org/dsbo.

   Bidders are encouraged to use the Directory to assist in locating MWBEs for the work and supplies required on the Project. Bidders are reminded that changes may be made to the Directory at any time in accordance with the City's MWBE Ordinance and procedures established to administer this program and a current copy of the Directory must always be used in preparing a bid. MWBE certification or listing in the Directory is not a representation or warranty by the City as to the qualifications of any listed MWBE.

6. In accordance with the provisions of the MWBE Ordinance, DSBO will evaluate each bid to determine the responsiveness of the bid to the requirements of the MWBE Ordinance. In determining whether a bidder's committed level of participation meets or exceeds the stated MWBE goal, DSBO shall base its calculation of applicable

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amounts and percentages on the total base bid amount, not including any listed alternates, of each bid as follows:

a. The bid information provided by the agency will be used to determine the total base bid amount of each bid. Each bidder's total base bid amount will be multiplied by the MWBE percentage established for the project to determine the exact dollar amount of required MWBE participation for the Project. This amount will then be compared against the exact dollar amounts for the MWBE committed for participation by the bidder. If the total dollar amount of participation listed meets or exceeds the established MWBE dollar amount goal listed, then DSBO will determine that the goal has been met.
b. In addition, DSBO will determine the exact commitment percentage for each listed MWBE by dividing the dollar amount listed for each MWBE by the total base bid dollar amount submitted by the bidder. These individual percentages, when totaled for all listed MWBE, will establish the total committed percentage level of MWBE participation that the bidder must comply with during the life of the contract. In all cases, the committed percentage level of MWBE participation must equal or exceed the assigned MWBE goal for the Project.

c. In providing the exact dollar amount of participation for each listed MWBE, a bidder should take care never to round up in determining whether or not the total of these amounts meets or exceeds the established percentage goal. The goal must be met or exceeded by dollar amounts and percentages in order for DSBO to determine that the bidder has met or exceeded the applicable MWBE goal.

d. As previously mentioned, compliance with the MWBE goal will be determined on the base bid alone. If a bid contains alternates, participation contained in any alternate will not count towards satisfaction of the Project goal. However, should any designated alternate be selected by the City for inclusion in the contract ultimately awarded, the MWBE goal percentage level submitted at bid time, on the base bid, will also apply to the selected alternates and must be maintained for the life of the contract on the total contract amount, including any alternate work. Thus, even though such participation will not be considered in evaluating bids, bidders are urged to consider participation in preparing bids for designated alternates.

e. On projects where force account or allowance bid items have been included, bidders must meet the MWBE goal percentage based upon the total base bid, including all such items that are submitted to the City. However, when a force account or allowance is designated by the City to be either performed or purchased from a specific company, the bidder may back out the dollar amount of the force account or allowance from the total base bid and meet the MWBE goal on the remaining reduced amount.

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f. On bids which, at the time of bid opening, are equal to or exceed Five Million Dollars ($5,000,000.00), including any alternates which may be selected, only sixty percent (60%) of the value of the commercially useful function performed by MWBE suppliers shall count toward satisfaction of the Project goal. On Projects under Five Million ($5,000,000.00) the value of the commercially useful function of MWBE supplier(s) will count at a one hundred percent (100%) level. Manufacturer's representatives and packagers shall be counted in the same manner as brokers.

g. In utilizing the MWBE participation of a Broker only the bona fide commissions earned by such Broker for its performance of a commercially useful function will count toward meeting the Project goals. The bidder must separate the bona fide brokerage commissions from the actual cost of the supplies or materials provided to determine the actual dollar amount of participation that can be counted towards meeting the goal.

7. On or before the third (3rd) working day after bid opening, all of the Bidders are required to submit an executed "Letter of Intent" for each MWBE listed on the Bid Form as a joint venture member, subcontractor, supplier, manufacturer, manufacturers' representative or broker of any tier. **An MWBE Prime Bidder needs to submit a Letter of Intent for itself for self-performed work** and must identify their level of participation on the designated MWBE participation page bound herein. A Letter of Intent shall be submitted only for the MWBEs listed at the time of bid opening, since this is the only participation that will be counted toward satisfaction of the project goal. A form for the MWBE Letter of Intent is included with the Bid Form. The MWBE Letter of Intent is a written communication from the Bidder to the City evidencing an understanding that the Bidder has or will enter into a contractual relationship with the MWBE or that its subcontractor(s) and supplier(s), manufacturer(s), manufacturers' representative(s) and broker(s) will do so. Each MWBE Letter of Intent shall be accompanied by a copy of the City and County of Denver's MWBE certification letter for each proposed MWBE identified at bid time. Bidders are urged to carefully review these Letters before submission to the City to ensure that they are properly completed and executed by the appropriate parties.

Good Faith Effort

In preparing a bid to demonstrate a good faith effort, bidders should consider the following instructions relating to compliance with the MWBE Ordinance:

1. If the bidder or proposer has not fully met the project goal as provided in section 28-60, then it shall demonstrate that it has made good faith efforts to meet such goal. The bidder or proposer shall furnish to the director, within three (3) working days after bid opening by the City or on or before the time of the final project-specific proposal submitted to and authorized by the City pursuant to a competitive selection process, or bid selection by a private owner, a detailed statement of its good faith efforts to meet the project goal set by the director. This statement shall address each of the items in

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subsection (b) and any additional criteria that the director may establish by rule or regulation consistent with the purposes of this division 3. Good faith efforts must be demonstrated to be meaningful and not merely for formalistic compliance with this Division 3. The scope and intensity of the efforts will be considered in determining whether the bidder or proposer has achieved a good faith effort.

2. The statement of good faith efforts shall include a specific response and verification with respect to each of the following good faith effort categories, which may be further defined by rule or regulation. A bidder or proposer may include any additional information it believes may be relevant. Failure of a bidder or proposer to show good faith efforts as to any one (1) of the following categories shall render its overall good faith effort showing insufficient and its bid or proposal non-responsive:

    a. If prebid or preselection meetings are scheduled by the City at which MWBEs may be informed of subcontracting or joint venture opportunities under a proposed contract to be bid, or procured pursuant to the competitive selection process, attendance at such prebid or preselection meetings is not mandatory; however, bidders and proposers are responsible for the information provided at these meetings.
    b. The bidder or proposer must solicit through all reasonable and available means, the interest of all MWBEs certified in the scopes of work of the contract. The bidder or proposer must solicit the interest of such MWBEs within sufficient time, prior to the bid opening or date of final project-specific proposal in the case of a competitive selection process, to allow such MWBEs to respond to the solicitation. The bidder or proposer must determine with certainty if the MWBEs are interested by demonstrating appropriate steps to follow up initial solicitations.
    c. The bidder or proposer must select portions of the work of the contract to be performed by MWBEs in order to increase the likelihood that the project goal will be achieved. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate MWBE participation as subcontractors or joint venturers, and for bidder or proposer self-performed work, as suppliers, manufacturers, manufacturer's representatives and brokers, all reasonably consistent with industry practice, even when the bidder or proposer would otherwise prefer to perform these work items with its own forces. The bidder or proposer must identify what portions of the contract will be self-performed and what portions of the contract will be opened to solicitation of bids, proposals and quotes from MWBEs. All portions of the contract not self-performed must be solicited for MWBE participation. The ability or desire of a bidder or proposer to perform the work of a contract with its own forces does not relieve the bidder or proposer of the responsibility to meet the project goal or demonstrate good faith efforts to do so.
    d. The bidder or proposer, consistent with industry practice, must provide MWBEs at a clearly stated location with timely, adequate access to and information about the plans, specifications, and requirements of the contract, including bonding and insurance requirements, if any, to assist them in responding to a solicitation.

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e. The bidder or proposer must negotiate in good faith with interested MWBEs and provide written documentation of such negotiation with each such MWBE.
f. For each MWBE which contacted the bidder or proposer or which the bidder or proposer contacted or attempted to subcontract or joint venture with, consistent with industry practice, the bidder or proposer must supply a statement giving the reasons why the bidder or proposer and the MWBE did not succeed in negotiating a subcontracting, supplier, manufacturer, manufacturer's representative, broker or joint venture agreement, as applicable.

3. The bidder or proposer must provide verification that it rejected each non-utilized MWBE because the MWBE did not submit the lowest bid or it was not qualified. Such verification shall include a verified statement of the amounts of all bids received from potential or utilized subcontractors, suppliers, manufacturers, manufacturer's representatives, brokers or joint venturers on the contract, whether or not they are MWBEs. In making such a determination of not being qualified, the bidder or proposer shall be guided by the definition of qualified in section 28-54(42), but evidence of lack of qualification must be based on factors other than solely the amount of the MWBE's bid. For each MWBE found not to be qualified by the bidder or proposer, the verification shall include a statement giving the bidder's or proposer's reasons for its conclusion. A bidder's or proposer's industry standing, or group memberships may not be the cause of rejection of an MWBE. A bidder or proposer may not reject an MWBE as being unqualified without sound reasons based on a reasonably thorough investigation and assessment of the MWBE's capabilities and expertise.

4. If requested by a solicited MWBE, the bidder or proposer must make reasonable efforts to assist interested MWBEs in obtaining bonding, lines of credit, or insurance as required by the City or by the bidder or proposer, provided that the bidder or proposer need not provide financial assistance toward this effort.

5. If requested by a solicited MWBE, the bidder or proposer must make reasonable efforts to assist interested MWBEs in obtaining necessary and competitively priced equipment, supplies, materials, or related assistance or services for performance under the contract, provided that the bidder or proposer need not provide financial assistance toward this effort.

6. The bidder or proposer must use the DSBO MWBE directories to identify, recruit, and place MWBEs.

7. In determining whether a bidder or proposer has satisfied good faith efforts as to a project goal, the success or failure of other bidders or proposers on the contract in meeting such project goal may be considered.

Continuing Commitments.
In accordance with the provisions of the MWBE Ordinance, the bidder agrees that it is committed to meeting either the MWBE participation goal or the MWBE participation set

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forth in its statement of good faith. This commitment must be expressly indicated on the "Commitment to MWBE SBE Participation" form included with the Bid Form. This commitment includes the following understandings:

1. The bidder understands it must maintain MWBE goals throughout the performance of the Contract pursuant to the requirements set out in D.R.M.C. 28-72.

2. The bidder understands that it must establish and maintain records and submit regular reports, as required, which will allow the City to assess progress in achieving the MWBE participation goal.
3. The bidder understands that if change orders or any other contract modifications are issued under the contract, the bidder shall have a continuing obligation to immediately inform DSBO in writing of any agreed upon increase or decrease in the scope of work of such contract, upon any of the bases discussed in Section 28-73 of the MWBE Ordinance, regardless of whether such increase or decrease in scope of work has been reduced to writing at the time of notification.
4. The bidder understands that if change orders or other contract modifications are issued under the contract, that include an increase in scope of work of a contract for construction, reconstruction, or remodeling, 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 immediately submitted to DSBO for notification purposes. 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 or by the contractor shall be subject to a goal for MWBEs equal to the original goal on the contract which was included in the bid. The contractor shall satisfy such goal with respect to such changed scope of work by soliciting new MWBEs in accordance with Section 28-73 of the MWBE Ordinance as applicable, or the contractor must show each element of modified good faith set out in Section 28-75(c) of the MWBE Ordinance. The contractor shall supply to the director the documentation described in Section 28-75(c) of the MWBE Ordinance with respect to the increased dollar value of the contract.

All bidders are charged with knowledge of and are solely responsible for complying with each and every provision of the MWBE Ordinance in making a bid and, if awarded, in performing the work described in the Contract Documents. Failure to comply with these provisions could constitute cause for rejection of a bid or subject the selected contractor to sanctions set forth in the MWBE Ordinance. These instructions are intended only to generally assist the bidder in preparing and submitting a compliant bid. Should any questions arise regarding specific circumstances, bidders must consult the MWBE Ordinance or contact the Project’s designated DSBO representative at (303) 342-2180.

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IB-25 DIVERSITY AND INCLUSIVENESS IN CITY SOLICITATIONS

Each Bidder shall, as a condition of responsiveness to this solicitation, complete and return the "Diversity and Inclusiveness in City Solicitations Information Request Form" with their Bid.

Using the "Diversity and Inclusiveness in City Solicitations Information Request Form" please state whether you have a diversity and inclusiveness program for employment and retention, procurement and supply chain activities, or customer service and provide the additional information requested on the form. The information provided on the "Diversity and Inclusiveness in City Solicitations Information Request Form" will provide an opportunity for City contractors to describe their own diversity and inclusiveness practices. Contractors are not expected to conduct intrusive examinations of its employees, managers, or business partners in order to describe diversity and inclusiveness measures. Rather, the City simply seeks a description of the contractor's current practices, if any.

Diversity and Inclusiveness information provided by City contractors in response to City solicitations for services or goods will be collated, analyzed, and made available in reports consistent with City Executive Order No. 101. However, no personally identifiable provided by or obtained from contractor's will be in such reports.

In order for the agency or City to consider the bid or proposal, Contractors must complete the electronic version of the Diversity and Inclusiveness In City Solicitations Form then **print the completed form and include the hard copy as part of its bid documents. A proposal or response to a solicitation by a contractor/consultant that does not include this completed form shall be deemed non-responsive and rejected.** The form is found at: https://fs7.formsite.com/CCDenver/form161/index.html

The Diversity and Inclusiveness form is separate from the requirements established by DSBO, and must always be completed regardless of whether or not there are any goals assigned to the project.

IB-26 WAGE RATE REQUIREMENTS

Contractor shall comply with, and agrees to be bound by, all requirements, conditions and City determinations regarding the Payment of Prevailing Wages Ordinance, Sections 20-76 through 20-79, D.R.M.C. 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 request for qualifications/proposals was advertised: February 21, 2020

Prevailing wage and fringe rates will adjust on, and only on, the anniversary of the date the

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Contract was fully executed. Unless expressly provided for in this Agreement, Contractor will receive no additional compensation for increases in prevailing wages or fringe benefits.

Contractor shall provide the Auditor with a list of all subcontractors providing any services under the contract.

Contractor shall provide the Auditor with electronically-certified payroll records for all covered workers employed under the contract.

Contractor shall prominently post at the work site the current prevailing wage and fringe benefit 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.

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 City may, by written notice, suspend or terminate work if Contractor fails to pay required wages and fringe benefits.

IB-27 CONSTRUCTION SCHEDULING

The bidder should refer to the General Conditions, Special Conditions, and Division I of the Technical Specifications for scheduling requirements for this contract.

IB-28 EQUAL EMPLOYMENT OPPORTUNITY

1. Article III, Division 2 of Chapter 28 applies to this contract. It is the policy of the City to provide equal opportunity in employment without regard to race, color, creed, sex, national origin, religion, marital status, or political opinion or affiliation. It is hereby deemed and declared to be for the public welfare and in the best interest of the City to require bidders, contractors and subcontractors soliciting and receiving, directly or indirectly, compensation from or through the City, for the performance of such contracts, to meet certain affirmative action and equal employment opportunity requirements. Additionally, contractors and subcontractors that hold any contracts which are federally-assisted shall be required to adhere to the Department of Labor's Contract Compliance program under Executive Order 11246 as defined in the regulations of the Secretary of Labor at 41 CFR Chapter 60-4.

2. After the Notice to Apparent Low Bidder has been issued, the Apparent Low Bidder shall submit the following to the Division of Small Business Opportunity:

   (a) A statement that the bidder shall implement the affirmative action steps set forth in the Rules and Regulations and Bid Conditions of the Manager of Public Works pertaining to Equal Employment Opportunity, attached hereto, or the bidder's affirmative action plan which meets these requirements, and

   (b) A projection of its anticipated workforce for this contract on the attached "EEO

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Questionnaire." Both of these submittals are required before the Division of Small Business Opportunity will approve the Notice to Proceed.

3. The bidder which is awarded this contract shall comply with the provisions and requirements, including the goals of minority and female participation and specific affirmative action steps, set forth in the Rules and Regulations and Bid Conditions of the Manager of Public Works pertaining to Equal Employment Opportunity, as said rules and regulations may be amended or readopted from time to time by the Manager of Public Works or the Director of the Division of Small Business Opportunity.

4. In accordance with DRMC 28-46, if this contract is funded in whole or in part by the United States of America or is otherwise subject to requirements having the force of law of the United States of America, then such requirements of the United States of America shall govern and control.

IB-29 CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

The bidder certifies, by submission of its bid or acceptance of this contract, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or involuntarily excluded from participation in any government contract by any Federal, State, or local government department or agency. It further agrees by submitting its bid that it will include this clause without modification in all lower tier transactions, solicitations, proposals, contracts, and subcontracts. Where the bidder or any lower tier participant is unable to certify to this statement, it shall attach an explanation to its bid.

IB-30 INSURANCE REQUIREMENTS AND SAFETY MANUAL

Bidders shall assure that insurance requirements contained in the Contract Documents are met. In accordance with the provisions of General Contract Condition 1601, INSURANCE, the minimum insurance requirements for this Contract are set forth in the INSURANCE REQUIREMENTS contained in the Special Conditions Section of the Contract Documents. Bidders are urged to consider in preparing a bid hereunder that the Contractor and all subcontractors performing Work on the Project must comply with each condition, requirement or specification set forth, unless such requirements are specifically amended in writing by DEN Risk Management. The Contractor must either include all subcontractors performing work hereunder as Additional Named Insureds under each of its required policies or furnish a separate certificate for each subcontractor evidencing compliance under their separate insurance program.

If this Project is identified as an Owner Controlled Insurance Program (OCIP) or a Rolling Owner Controlled Insurance Program (ROCIP) Project (hereinafter collectively referred to as "ROCIP") (i) the Insurance Requirements provided in the Contract Documents will explicitly state whether or not this Project is a ROCIP or Non-ROCIP Project, (ii) the City will provide certain insurance for the Contractor and its subcontractors, and (iii) the DEN ROCIP Insurance Manual and DEN ROCIP Safety Manual will be included in the Contract Documents and should be closely reviewed in preparing any bid to fully understand all Contractor and subcontractor obligations under a ROCIP.

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IB-31 INVOICING

Unless otherwise directed or authorized, in writing by DEN, all Applications for Payment and all supporting documents (including, but not limited to lien waivers, sworn statements etc.) for Prime Contractor and its subcontractors, shall be in electronic format and shall be submitted to DEN using the Oracle - Textura Payment Management (TPM™) system. In addition, the Contractor must comply with the bank Automated Clearing House (ACH) setup, conducted by Oracle, so the Contractor may send payment to its subcontractors electronically via ACH.

All fees associated with the TPM System are to be paid by the Contractor prior to billings for any work performed (the "Textura Fee"). **The Textura fee shall be included as a line item in the Contractor's bid with no mark up.**

Effective January 2018, Textura moved to a flat fee schedule as attached. Fees paid by Prime with no mark up, and subsequently reimbursed by the City, will no longer be calculated as a percentage of a task/contract amount but will instead be a flat amount. The City will provide the Textura Fee amount to the Contractor, who will then pay this amount to Textura directly. The Textura Fee should be included on a Contractor's pay application to the City and the City will reimburse the Contractor as a pass through expense for the Textura Fee with no mark-up.

The attached Textura Fee Schedule, included in the bid documents, is only to be used as a reference.

IB-32 PROJECT CONTROLS REQUIREMENTS

The Contractor will be required to use the designated Project Management Information System (PMIS) as set forth in the Technical Specifications. The PMIS is Airport Infrastructure Management's tool for project and information management, data analysis and document control. Denver International Airport will be responsible for providing the licensing and training for PMIS.

IB-33 SCHEDULE OF EVENTS

This projected schedule is an estimated timeline and is subject to change at the sole discretion of the City.

Event	Date
Bid Issued	February 21, 2020
Deadline to pre-register for guided tour	March 2, 2020, 2:00 PM
Pre-Bid Conference	March 11, 2020, 2:00 PM
Last Date to Submit Questions	March 19, 2020, 2:00 PM
Bid Opening Date	March 26, 2020, 1:00 PM

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REQUEST FOR "OR EQUAL" APPROVAL

Contract No.:	201951778
Title:	Concourse A & C Pre-Conditioned Air Re-Life

This request, **in duplicate**, must be received by the of Business Management Services, attention Tony Deconinck, Room 8810, Airport Office Building (AOB), Denver International Airport, 8500 Peña Blvd., Denver, CO 80249-6340, or at contract.procurement@flydenver.com, by noon at least 10 days prior to bid date.

To be completed and signed by requesting party:

Specification Section/Drawing Number:	Page No./Paragraph No./Subparagraph No.:
Specified Product:	Specified Manufacturer:
	Specified Model No.:
"Or Equal" Product:	"Or Equal" Manufacturer:
	"Or Equal" Model No.
Reason for "Or Equal" substitution:	
Prior Applications [Installations of at least 3 years length]: (1) Project:_____ Date:_____ (2) Project:_____ Date:_____ (3) Project:_____ Date:_____	

[PAGE 1 OF 2 PAGES]

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General product literature/catalog cuts/drawings or other appropriate information detailing the "Or Equal" product with respect to the project specifications must be attached to this form for approval.

I have reviewed the attached product literature and certify the following:

(1) That the above described "Or Equal" product fulfills the specification requirements as detailed in the contract documents.
(2) That the installation of the above described "Or Equal" product in no way impacts the spatial requirements of the project.
(3) That I, if selected as the Contractor, shall modify any building system(s) (HVAC, structural, electrical, etc.) impacted by the use of the above described "Or Equal" product at no additional cost to the City and County of Denver and shall make no claim for delay with respect to any such modification.
(4) That the above described "Or Equal" product meets all physical and performance attributes of the specified material or equipment except (if no difference, so state):

_____

_____

_____

REQUESTING PARTY: _____

Date: _____ By: _____

Title: _____

For City use:

☐ Approved ☐ Disapproved Date: _____

Reason for disapproval [if applicable]:

DESIGNER OF RECORD:
[Signature]

PROJECT MANAGER: Date:
[Signature]

SVP-AIM: Date:
[Signature]

Bidder(s) Notified By Addendum No. Date:

THIS IS PAGE 2 OF 2 PAGES

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DENVER INTERNATIONAL AIRPORT
BID FORMS

CONTRACT NAME: Concourse A & C Pre-Conditioned Air Re-Life
Contract No.: 201951778

Bid Letter

BIDDER_____

Chief Executive Officer
City and County of Denver
Business Management Services (Procurement) Office
Airport Office Building, Room 8810
Denver International Airport
8500 Peña Boulevard
Denver, Colorado 80249

This letter is in response to the Notice of Invitation for Bids first published on February 21, 2020, for Contract No. 201951778, Denver International Airport, Concourse A & C Pre-Conditioned Air Re-Life.

This contract is for full replacement of mechanical equipment on Concourses A and C that supply the PC Air units on Concourses A and C. This scope also includes the replacement of floor slabs in each plant with structural, void form floors and micro piles to mitigate floor heaving that currently plagues the existing plants. In addition to these improvements, walls will be relocated in the concourse A plant in order to provide additional space for future ice storage that the new system is designed to connect into if DEN so chooses. The project will be phased to coordinate with the opening of the concourse expansions on Concourses A and C.

The undersigned Bidder declares that it has carefully examined the location of the proposed work and has carefully read and examined all of the contract documents which include, but are not limited to, the Contract Drawings, Technical Specifications, Construction Contract General Conditions, Special Conditions, Instruction to Bidders, and EEO provisions, and hereby proposes to furnish all labor, materials, equipment, tools, transportation and services, and to discharge all duties and obligations necessary and required to perform and complete the Work as required in the contract documents which are provided herewith and by this reference made a part hereof for the prices shown in the bid forms and totaled below:

TOTAL BID Amount:_____

_____

_____Dollars and _____ Cents

($_____).

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The undersigned acknowledges receipt, understanding and full consideration of the following addenda to the contract documents:

Addenda Nos.:_____

The undersigned agrees that this bid is a firm offer to the City to perform and complete the Contract described above which cannot be withdrawn for one hundred twenty (120) calendar days after the bids are opened or until after a contract for the work described in these bid documents is fully executed by the City, whichever date is earlier.

The undersigned Bidder hereby agrees to appear at Denver International Airport, Business Management Services Office, Room 8810, Airport Office Building, at any time within ten (10) calendar days from the date of a written notice from the CEO to do so, mailed, emailed, or faxed to the business address of Bidder and at that time the Bidder shall: (1) deliver an executed Contract which conforms with this bid; (2) furnish the required performance and payment bonds in the sum of the Total Contract Bid Amount shown above, executed by a surety company acceptable to the CEO; and (3) furnish the required insurance documents.

Enclosed herewith is a bid guarantee, as defined in the Instructions to Bidders, in the amount of which bid guarantee the undersigned Bidder agrees is to be paid to and become the property of the City as liquidated damages should the bid be considered to be the best by the City and the undersigned Bidder notified that it is the apparent low bidder and it fails to enter into contract in the form prescribed and to furnish the required performance and payment bonds and evidences of insurance within ten (10) calendar days as stipulated above.

Attached and incorporated herein are the proposed Schedule of Prices and Quantities and Bid Data Forms. All of the forms must be completed. Bidder acknowledges that the City may incorporate, at its option, any or all of the data submitted by the Bidder into a contract arising out of this Bid.

The undersigned Bidder acknowledges the right of the City to waive informalities in the bids, to reject any or all bids submitted, and to re-advertise for bids.

The undersigned certifies that it has examined and is fully familiar with all of the provisions of the contract documents and is satisfied that they are accurate; that it has carefully checked all words and figures and all statements made in these Bid forms; and that it has satisfied itself with respect to the actual site conditions and the nature and location of the Work, the general and local conditions which may be encountered in the performance of the Work, and other matters which in any way affect the Work or the cost thereof.

[CERTIFICATION AND SIGNATURE ON FOLLOWING PAGES]

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This bid is submitted upon the declaration that neither, I (we), nor, to the best of my (our) knowledge, none of the members of my (our) firm or company have either directly or indirectly entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this bid.

Dated this _____ day of _____, _____.

BUSINESS ADDRESS OF BIDDER: _____

City, State, Zip Code: _____

Telephone Number of Bidder: (____) _____

Fax Number of Bidder: (____) _____

Bidder Social Security or Employer ID: _____

Bidder Email Address: _____

Bidder's Point of Contact Name: _____

SIGNATURE OF BIDDER:

PRINT NAME OF BIDDER:

_____

Attest:

(Corporate Seal) _____

_____ By: _____

Secretary President

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SCHEDULE OF PRICES AND QUANTITIES

The Schedule of Prices and Quantities which apply to this contract are contained in the pages immediately following this page.
These pages are not included in the page numbering of this contract document.

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DENVER INTERNATIONAL AIRPORT

BID TABULATION: SCHEDULE OF PRICES AND QUANTITIES

Concourse A & C Pre-Conditioned Air Re-Life

SCOPE

ITEM NO.	DESCRIPTION AND PRICE	QUANTITY	UNIT	UNIT PRICE	EXTENDED PRICE
GENERAL REQUIREMENTS					
01 50 50	Mobilization _____dollars and_____cents. ($_____) lump sum.	1	LS		
01 66 10 TNP	Storage and Protection _____dollars and_____cents. ($_____) per lump sum.	1	LS		
01 31 00	Project Management and Coordination _____dollars and_____cents. ($_____) per lump sum.	1	LS		
IFB	Textura Fee _____dollars and_____cents. ($_____) per lump sum.	1	LS		
Division 01, all others	Other General Requirements _____dollars and_____cents. ($_____) per lump sum.	1	LS		
	Division Subtotal				**$ -**
EXISTING CONDITIONS					
02 41 19	Selective Demolition _____dollars and_____cents. ($_____) per Lump Sum.	1 - CCA 1 - CCC	LS LS		
	Division Subtotal				**$ -**
CONCRETE					
03 30 00	Cast-In-Place Concrete _____dollars and_____cents. ($_____) per Lump Sum.	1 - CCA 1 - CCC	LS LS		
	Division Subtotal				**$ -**
METALS					
Division 5	Metals _____dollars and_____cents. ($_____) per Lump Sum.	1 - CCA 1 - CCC	LS LS		
	Division Subtotal				**$ -**
THERMAL AND MOISTURE PROTECTION					
Division 7	Thermal and Moisture Protection _____dollars and_____cents. ($_____) per Lump Sum.	1 - CCA 1 - CCC	LS LS		
	Division Subtotal				**$ -**
OPENINGS					
Division 8	Openings _____dollars and_____cents. ($_____) per Lump Sum.	1 - CCA 1 - CCC	LS LS		
	Division Subtotal				**$ -**

FINISHES

Division 09	Finishes	1 - CCA	LS		
	_____dollars	1 - CCC	LS		
	and_____cents.				
	($_____) per Lump Sum.				
	Division Subtotal				**$ -**

HEATING, VENTILATING, AND AIR CONDITIONING

Division 23	Selective Demolition for Mechanical	1 - CCA	LS		
	_____dollars	1 - CCC	LS		
	and_____cents.				
	($_____) per Lump Sum.				
	Division Subtotal				**$ -**

ELECTRICAL

Division 26	Electrical	1 - CCA	LS		
	_____dollars	1 - CCC	LS		
	and_____cents.				
	($_____) per Lump Sum.				
	Division Subtotal				**$ -**

COMMUNICATIONS

Division 27	Communications	1 - CCA	LS		
	_____dollars	1 - CCC	LS		
	and_____cents.				
	($_____) per Lump Sum.				
	Division Subtotal				**$ -**

ELECTRICAL SAFETY AND SECURITY

Division 28	Electrical Safety and Security	1 - CCA	LS		
	_____dollars	1 - CCC	LS		
	and_____cents.				
	($_____) per Lump Sum.				
	Division Subtotal				**$ -**

EARTHWORK

Division 31	Earthwork	1 - CCA	LS		
	_____dollars	1 - CCC	LS		
	and_____cents.				
	($_____) per Lump Sum.				
	Division Subtotal				**$ -**

Base Scope Total: **$ -**

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DENVER INTERNATIONAL AIRPORT

Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Data Forms

Bidder shall submit its Bid Data in accordance with the format shown on each of the following Bid Data Forms. Bidder shall prepare and use as many sheets as are necessary to provide the information required. Bidder shall ensure that each page of its Bid Data is completed and properly identified with the Bid Data form name, Bidder's name, and page number.

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DENVER INTERNATIONAL AIRPORT

Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Data Forms
INFORMATION ABOUT CONTRACTOR

1. Name of Bidder/Contractor: _____

2. Type of business entity: _____
NOTE: If Bidder is a **partnership** or **joint venture**, give full names of all partners or joint venturers. Bid must be signed by all joint venturers. If Bidder is a **limited liability company**, bid must be signed by authorized manager (may be signed by member-manager if LLC is organized to allow management by members).

3. Prequalified by City and County of Denver as Construction Contractor : Categories:_____

Monetary Limit:_____

4. Address of Contractor: _____

_____

_____

Telephone:_____ Fax: _____

Email Address:_____

5. Established where and when: _____

6. Contractor's Banks: _____

_____

7. Principal Officers of Contractor (managers and members if LLC):

Name: _____ Name:_____

Title: _____ Title:_____

Name: _____ Name: _____

Title: _____ Title: _____

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8. Bidder's/Contractor's City and County of Denver Contractor License if it has obtained one:

License No.: _____

Class: _____

A contractor license is required prior to start of construction but not prior to bid submittal.

9. Bidder's/Contractor's state of incorporation (state of organization if an LLC or partnership): _____

10. Bidder's Surety: _____

11. Surety's State of Incorporation: _____

12. Address of Contractor in other areas (if different from No. 4): _____

_____

_____

13. Name and address of person to receive payments: _____

_____

_____

_____

14. If the Bidder/Contractor is a joint venture, it shall attach a certified copy of the joint venture agreement. The joint venture agreement will not be included as a contract document.

15. The Bidder/Contractor shall identify all applicable labor agreements (if any) to be used in the performance of the Work:

_____

_____

_____

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Bidder_____

DENVER INTERNATIONAL AIRPORT

Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Data Forms

LIST OF PROPOSED SUBCONTRACTORS WHICH ARE NOT DBE SUBCONTRACTORS

Bidder shall list below the name, business address, work assignment and dollar value of each subcontractor that is not a DBE subcontractor which will perform work or labor or provide services to the Bidder relating to this contract in an amount greater than one and one-half percent of the Bidder's total bid. Only one subcontractor for each portion of the work shall be listed. Any proposed subcontractors to be utilized by the Bidder that are certified as a Small Business Enterprise shall also be listed on the "List of Proposed Subcontractors" attached to these Bid Forms.

If the Bidder does not identify a subcontractor to perform portions of the work which could be subcontracted on this form or the List of Proposed DBE Subcontractors, the Bidder, if it is awarded the contract, agrees not to subcontract such portions that exceed one and one half percent of the total bid amount until the Contractor has advised the SVP-AIM in writing of the reasons why the subcontractor was not listed in the bid and complied with the requirements of General Condition 502.

If the Bidder is awarded the contract and does not enter into a subcontract with a subcontractor listed below or on the List of Proposed DBE Subcontractors, the Contractor agrees not to subcontract any of the work assignment identified for that subcontractor until the Contractor has advised the SVP-AIM in writing of the reasons why a different subcontractor is being used and has obtained approval of the SVP-AIM of the substitution. This requirement does not affect the applicability of 502.

Subcontractor	Work Assignment	Subcontract Dollar Value
NAME: _____ ADDRESS:_____ _____ PHONE:		

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Subcontractor	Work Assignment	Subcontract Dollar Value
NAME: _____ ADDRESS:_____ _____ PHONE:		
NAME: _____ ADDRESS:_____ _____ PHONE:		
NAME: _____ ADDRESS:_____ _____ PHONE:		
NAME: _____ ADDRESS:_____ _____ PHONE:		
NAME: _____ ADDRESS:_____ _____ PHONE:		
NAME: _____ ADDRESS:_____ _____ PHONE:		
NAME: _____ ADDRESS:_____ _____ PHONE:		
NAME: _____ ADDRESS:_____ _____ PHONE:		

(This page can be duplicated if additional sheets are required.)

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EEO QUESTIONNAIRE
Contract No.: 201951778

1. Name of Business:_____

2. Address:_____

3. City, State, Zip Code:_____

4. Telephone Number: (_____) _____

5. Name and title of your firm's EEO Contact:_____

6. Are you an affiliate or a subsidiary of another business organization (branches, etc.)?
   ☐ Yes ☐ No

7. Type of business you are engaged in:_____

8. Does the organization have a procedure for resolving discrimination complaints?
   ☐ Yes ☐ No

9. Has your firm been charged with discrimination within the past eighteen (18) months?
   ☐ Yes ☐ No

10. Is your firm required to submit an EEO-1 annually to the EEOC?
    ☐ Yes ☐ No

11. Are you now working or have you worked on a City and County of Denver contract during the past twelve (12) months? ☐ Yes ☐ No
    If yes, complete the following information:

Type of Contract	Contract Number	Total Cost of Each Contract

(You may use additional sheets if necessary)

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PROJECTION OF ANTICIPATED WORKFORCE
Contract No. 201951778

12. List the number of anticipated new employees needed by the contractor to perform this contract by trade/craft positions.

ANTICIPATED NUMBER OF NEW EMPLOYEES FOR THIS CONTRACT

Trade Craft	Estimated Total Manpower	Estimated Total Hours	Number of Employees Minority/Female	Total Estimated Employees Minority/Female
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

13. What is the anticipated number of employees from the apparent low bidder's current work force to be utilized to perform this contract?_____

14. Estimate manpower utilization for the project below:

ESTIMATE OF MANPOWER UTILIZATION

Trade Craft	Estimated Total Manpower	Estimated Total Hours	Number of Employees Minority/Female	Total Estimated Employees Minority/Female
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

15. Will the estimated total manpower (anticipated new hires and current staff to be utilized on this contract) meet the City's minority employment and female employment goals?
☐ Yes ☐ No

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Bidder_____

DENVER INTERNATIONAL AIRPORT

Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Data Forms
EQUAL OPPORTUNITY REPORT STATEMENT

Each Bidder shall complete and sign the Equal Opportunity Report Statement. A Bid may be considered unresponsive and may be rejected, in the Owner's sole discretion, if the Bidder fails to provide the fully executed Statement or fails to furnish required data. The Bidder shall also, prior to award, furnish such other pertinent information regarding its own employment policies and practices as well as those of its proposed subcontractors as the FAA, the Owner, or the Executive Vice Chairman of the President's Committee may require.

The Bidder shall furnish similar Statements executed by each of its first-tier and second-tier subcontractors and shall obtain similar compliance by such subcontractors, before awarding subcontracts. No subcontract shall be awarded to any non-complying subcontractor.

Equal Opportunity Report Statement
as Required in 41 CFR 60-1.7(b)

The Bidder shall complete the following statements by checking the appropriate blanks. Failure to complete these blanks may be grounds for rejection of bid:

1. The Bidder has ___ has not ___ developed and has on file at each establishment affirmative action programs pursuant to 41 CFR 60-1.40 and 41 CFR 60-2.

2. The Bidder has ___ has not ___ participated in any previous contract or subcontract subject to the equal opportunity clause prescribed by Executive Order 11246, as amended.

3. The Bidder has ___ has not ___ filed with the Joint Reporting Committee the annual compliance report on Standard Form 100 (EEO-1 Report).

4. The Bidder does ___ does not ___ employ fifty or more employees.

Dated:_____

_____
(Name of Bidder)

By:_____

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Title:_____

Bidder_____

DENVER INTERNATIONAL AIRPORT

Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Data Forms

CERTIFICATION OF NON-SEGREGATED FACILITIES
(Must be completed and submitted with the Bid)

The Bidder certifies that it does not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not permit its employees to perform their services at any location under its control, where segregated facilities are maintained. The Bidder certifies further that it will not maintain or provide for its employees segregated facilities at any of its establishments, and that it will not permit its employees to perform their services at any location under its control, where segregated facilities are maintained. The Bidder agrees that a breach of this certification is a violation of the equal opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, parking lots, drinking fountains, recreation or entertainment areas, transportation and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or any other reason. The Bidder agrees that (except where it has obtained identical certification from proposed subcontractors for specific time period) it will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the equal opportunity clause, and that it will retain such certification in its files.

DATED: _____

_____
(Name of Bidder)

By:_____

Title:_____

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DIVERSITY AND INCLUSIVENESS IN CITY SOLICITATIONS

In order for the agency or City to consider the bid or proposal, Contractors must complete the electronic version of the Diversity And Inclusiveness In City Solicitations Form then **print the completed form and include the hard copy as part of its bid documents. A proposal or response to a solicitation by a contractor/consultant that does not include this completed form shall be deemed non-responsive and rejected.** The form is found at: https://fs7.formsite.com/CCDenver/form161/index.html

Using the form found in link listed above, please state whether you have a Diversity and Inclusiveness program for employment and retention, procurement and supply chain activities, or customer service and provide the additional information requested on the form. The information provided on the Diversity and Inclusiveness in City Solicitations Information Request Form will provide an opportunity for City contractors/consultants to describe their own diversity and inclusiveness practices. Contractors/consultants are not expected to conduct intrusive examinations of its employees, managers, or business partners in order to describe diversity and inclusiveness measures. Rather, the City simply seeks a description of the contractor/consultant's current practices, if any. Diversity and Inclusiveness information provided by City contractors/consultants in response to City solicitations for services or goods will be collated, analyzed, and made available in reports consistent with City Executive Order No. 101. However, no personally identifiable information provided by or obtained from contractors/consultants will be in such reports.

Insert the completed hard copy of the Diversity And Inclusiveness In City Solicitations Form immediately following this page.

INCLUDE A SIGNED HARD COPY OF THE COMPLETED FORM IN YOUR BID RESPONSE

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PREVAILING WAGES

The Prevailing Wage Schedule(s) which apply to this contract are contained in the pages immediately following this page.
These pages are not included in the page numbering of this contract document.

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DENVER
THE MILE HIGH CITY

TO: All Users of the City and County of Denver Prevailing Wage Schedules
FROM: Ryland Feno, Classification and Compensation Technician II
DATE: January 13, 2020
SUBJECT: Latest Change to Prevailing Wage Schedules

The effective date for this publication will be **Friday, January 10, 2020** and applies to the City and County of Denver for **BUILDING 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. CO20200020
Superseded General Decision No. CO20190020
Modification No. 1
Publication Date: 01/10/2020
(6 pages)

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

Attachments as listed above.

***Career Service Board approved to adjust all Davis Bacon classifications under $13.00 to comply with the city's minimum wage. The effective date is August 15, 2019. See page 6 for reference.**

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

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"General Decision Number: CO20200020 01/10/2020

Superseded General Decision Number: CO20190020

State: Colorado

Construction Type: Building

County: Denver County in Colorado.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Note: Under Executive Order (EO) 13658, an hourly minimum wage of $10.80 for calendar year 2020 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least $10.80 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 calendar year 2020. If this contract is covered by the EO and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must pay workers in that classification at least the wage rate determined through the conformance process set forth in 29 CFR 5.5(a)(1)(ii) (or the EO minimum wage rate,if it is higher than the conformed wage rate). The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/03/2020
1	01/10/2020

ASBE0028-002 07/01/2019

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR - MECHANICAL (Duct, Pipe & Mechanical System Insulation)	$ 32.98	14.73

CARP0055-002 11/01/2019

	Rates	Fringes
CARPENTER (Drywall Hanging		

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Only).....$ 29.95 10.99

CARP1607-001 06/01/2019

	Rates	Fringes
MILLWRIGHT	$ 32.00	16.43

ELEC0068-012 06/01/2019

	Rates	Fringes
ELECTRICIAN (Includes Low Voltage Wiring)	$ 36.50	16.18

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* ELEV0025-001 01/01/2020

	Rates	Fringes
ELEVATOR MECHANIC	$ 46.53	34.765

FOOTNOTE:
a.Vacation: 6%/under 5 years based on regular hourly rate for all hours worked. 8%/over 5 years based on regular hourly rate for all hours worked.
b. PAID HOLIDAYS: New Year's Day; Memorial Day; Independence Day; Labor Day; Veterans' Day; Thanksgiving Day; the Friday after Thanksgiving Day; and Christmas Day.

ENGI0009-017 05/01/2018

	Rates	Fringes
POWER EQUIPMENT OPERATOR (Crane)		
141 tons and over	$ 31.07	10.70
50 tons and under	$ 28.40	10.70
51 to 90 tons	$ 28.57	10.70
91 to 140 tons	$ 29.55	10.70

IRON0024-009 01/01/2019

	Rates	Fringes
IRONWORKER, ORNAMENTAL	$ 29.85	11.42

IRON0024-010 01/01/2019

	Rates	Fringes
IRONWORKER, STRUCTURAL	$ 29.85	11.42

PAIN0079-006 08/01/2017

	Rates	Fringes

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PAINTER (Brush, Roller and Spray; Excludes Drywall Finishing/Taping)	$ 20.50	8.41

PAIN0079-007 08/01/2017

	Rates	Fringes
DRYWALL FINISHER/TAPER	$ 21.20	8.41

PAIN0419-001 07/01/2016

	Rates	Fringes
SOFT FLOOR LAYER (Vinyl and Carpet)	$ 20.00	10.83

PAIN0930-002 07/01/2019

	Rates	Fringes
GLAZIER	$ 31.92	10.49

PLUM0003-009 06/01/2018

	Rates	Fringes
PLUMBER (Excludes HVAC Duct, Pipe and Unit Installation)	$ 35.48	15.94

PLUM0208-008 06/01/2018

	Rates	Fringes
PIPEFITTER (Includes HVAC Pipe and Unit Installation; Excludes HVAC Duct Installation)	$ 37.55	14.95

SFCO0669-002 04/01/2017

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers)	$ 36.73	20.47

SHEE0009-004 07/01/2019

	Rates	Fringes
SHEET METAL WORKER (Includes HVAC Duct Installation; Excludes HVAC Pipe and Unit Installation)	$ 34.62	18.10

SUCO2013-006 07/31/2015

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	Rates	Fringes
BRICKLAYER	$ 21.96	0.00
CARPENTER (Acoustical Ceiling Installation Only)	$ 22.40	4.85
CARPENTER (Metal Stud Installation Only)	$ 17.68	0.00
CARPENTER, Excludes Acoustical Ceiling Installation, Drywall Hanging, and Metal Stud Installation	$ 21.09	6.31
CEMENT MASON/CONCRETE FINISHER	$ 20.09	7.03
LABORER: Common or General	$ 14.49	5.22
LABORER: Mason Tender - Brick	$ 15.99	0.00
LABORER: Mason Tender - Cement/Concrete	$ 16.00	0.00
LABORER: Pipelayer	$ 16.96	3.68
OPERATOR: Backhoe/Excavator/Trackhoe	$ 20.78	5.78
OPERATOR: Bobcat/Skid Steer/Skid Loader	$ 19.10	3.89
OPERATOR: Grader/Blade	$ 21.50	0.00
ROOFER	$ 16.56	0.00
TRUCK DRIVER: Dump Truck	$ 17.34	0.00
WATERPROOFER	$ 12.71	0.00

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

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Office of Human Resources
Supplemental Rates
(Specific to the Denver projects)
Revision Date: 08-21-2019

Classification		Base	Fringe
Boilermaker		$30.97	$21.45
Iron Worker, Reinforcing		$18.49	$3.87
Laborer: Concrete Saw		$13.89	-
Paper Hanger		$20.15	$6.91
Plasterer		$24.60	$12.11
Plaster Tender		$13.00	-
Power Equipment Operator	Concrete Mixer - Less than 1 yd	$23.67	$10.67
	Concrete Mixer - 1 yd and over	$23.82	$10.68
	Drillers	$23.97	$10.70
	Loader - up to and incl 6 cu yd	$23.67	$10.67
	Loaders - over 6 cu yd	$23.82	$10.68
	Mechanic	$18.48	-
	Motor Grader	$23.97	$10.70
	Oilers	$22.97	$10.70
	Roller	$23.67	$10.67
Tile Finisher		$20.87	$8.42
Tile Setter		$26.83	$8.48
Truck Driver	Flatbed	$19.14	$10.07
	Semi	$19.48	$10.11
Waterproofer		$13.00	$0.00

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

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Textura

Below is the Textura Fee Schedule for this project

Project Value	Project Fee (GC + Sub Usage)
$0 - $49,999.99	$195
$50,000 - $99,999.99	$325
$100,000 - $249,999.99	$780
$250,000 - $499,999.99	$1,625
$500,000 - $999,999.99	$3,250
$1,000,000 - $2,999,999.99	$5,850
$3,000,000 - $4,999,999.99	$9,100
$5,000,000 - $9,999,999.99	$12,220
$10,000,000 - $19,999,999.99	$20,345
$20,000,000 - $49,999,999.99	$32,500
$50,000,000 - $99,999,999.99	$48,750
$100,000,000 - $199,999,999.99	$69,095
$200,000,000 - $299,999,999.99	$85,345
$300,000,000 - $399,999,999.99	$109,720
$400,000,000 - $499,999,999.99	$142,220
$500,000,000 - $999,999,999.99	$162,500
$1,000,000,000 - $1,999,999,999.99	$345,345
$2,000,000,000 - $4,999,999,999.99	$650,000
$5,000,000,000 - $9,999,999,999.99	$1,015,625
$10,000,000,000 or greater	$1,503,125

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W-9

Please complete the Request for Taxpayer Identification Number and Certification (Form W-9) and submit with your bid.
These pages are not included in the page numbering of this contract document.

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Form **W-9**
(Rev. December 2014)
Department of the Treasury
Internal Revenue Service

Request for Taxpayer Identification Number and Certification

Give Form to the requester. Do not send to the IRS.

Print or type
See **Specific Instructions** on page 2.

1 Name (as shown on your income tax return). Name is required on this line; do not leave this line blank.

2 Business name/disregarded entity name, if different from above

3 Check appropriate box for federal tax classification; check only **one** of the following seven boxes:

☐ Individual/sole proprietor or single-member LLC ☐ C Corporation ☐ S Corporation ☐ Partnership ☐ Trust/estate

☐ Limited liability company. Enter the tax classification (C=C corporation, S=S corporation, P=partnership) ▶ _____

Note. For a single-member LLC that is disregarded, do not check LLC; check the appropriate box in the line above for the tax classification of the single-member owner.

☐ Other (see instructions) ▶

4 Exemptions (codes apply only to certain entities, not individuals; see instructions on page 3):

Exempt payee code (if any) _____

Exemption from FATCA reporting code (if any) _____

(Applies to accounts maintained outside the U.S.)

5 Address (number, street, and apt. or suite no.)

Requester's name and address (optional)

6 City, state, and ZIP code

7 List account number(s) here (optional)

Part I Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. The TIN provided must match the name given on line 1 to avoid backup withholding. For individuals, this is generally your social security number (SSN). However, for a resident alien, sole proprietor, or disregarded entity, see the Part I instructions on page 3. For other entities, it is your employer identification number (EIN). If you do not have a number, see *How to get a TIN* on page 3.

Note. If the account is in more than one name, see the instructions for line 1 and the chart on page 4 for guidelines on whose number to enter.

Social security number

			–		–				

or

Employer identification number

		–							

Part II Certification

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me); and
2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding; and
3. I am a U.S. citizen or other U.S. person (defined below); and
4. The FATCA code(s) entered on this form (if any) indicating that I am exempt from FATCA reporting is correct.

Certification instructions. You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the certification, but you must provide your correct TIN. See the instructions on page 3.

Sign Here **Signature of U.S. person** ▶ **Date** ▶

General Instructions

Section references are to the Internal Revenue Code unless otherwise noted.

Future developments. Information about developments affecting Form W-9 (such as legislation enacted after we release it) is at *www.irs.gov/fw9*.

Purpose of Form

An individual or entity (Form W-9 requester) who is required to file an information return with the IRS must obtain your correct taxpayer identification number (TIN) which may be your social security number (SSN), individual taxpayer identification number (ITIN), adoption taxpayer identification number (ATIN), or employer identification number (EIN), to report on an information return the amount paid to you, or other amount reportable on an information return. Examples of information returns include, but are not limited to, the following:

- Form 1099-INT (interest earned or paid)
- Form 1099-DIV (dividends, including those from stocks or mutual funds)
- Form 1099-MISC (various types of income, prizes, awards, or gross proceeds)
- Form 1099-B (stock or mutual fund sales and certain other transactions by brokers)
- Form 1099-S (proceeds from real estate transactions)
- Form 1099-K (merchant card and third party network transactions)
- Form 1098 (home mortgage interest), 1098-E (student loan interest), 1098-T (tuition)
- Form 1099-C (canceled debt)
- Form 1099-A (acquisition or abandonment of secured property)

Use Form W-9 only if you are a U.S. person (including a resident alien), to provide your correct TIN.

If you do not return Form W-9 to the requester with a TIN, you might be subject to backup withholding. See *What is backup withholding?* on page 2.

By signing the filled-out form, you:

1. Certify that the TIN you are giving is correct (or you are waiting for a number to be issued),
2. Certify that you are not subject to backup withholding, or
3. Claim exemption from backup withholding if you are a U.S. exempt payee. If applicable, you are also certifying that as a U.S. person, your allocable share of any partnership income from a U.S. trade or business is not subject to the withholding tax on foreign partners' share of effectively connected income, and
4. Certify that FATCA code(s) entered on this form (if any) indicating that you are exempt from the FATCA reporting, is correct. See *What is FATCA reporting?* on page 2 for further information.

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Note. If you are a U.S. person and a requester gives you a form other than Form W-9 to request your TIN, you must use the requester's form if it is substantially similar to this Form W-9.

Definition of a U.S. person. For federal tax purposes, you are considered a U.S. person if you are:

- An individual who is a U.S. citizen or U.S. resident alien;
- A partnership, corporation, company, or association created or organized in the United States or under the laws of the United States;
- An estate (other than a foreign estate); or
- A domestic trust (as defined in Regulations section 301.7701-7).

Special rules for partnerships. Partnerships that conduct a trade or business in the United States are generally required to pay a withholding tax under section 1446 on any foreign partners' share of effectively connected taxable income from such business. Further, in certain cases where a Form W-9 has not been received, the rules under section 1446 require a partnership to presume that a partner is a foreign person, and pay the section 1446 withholding tax. Therefore, if you are a U.S. person that is a partner in a partnership conducting a trade or business in the United States, provide Form W-9 to the partnership to establish your U.S. status and avoid section 1446 withholding on your share of partnership income.

In the cases below, the following person must give Form W-9 to the partnership for purposes of establishing its U.S. status and avoiding withholding on its allocable share of net income from the partnership conducting a trade or business in the United States:

- In the case of a disregarded entity with a U.S. owner, the U.S. owner of the disregarded entity and not the entity;
- In the case of a grantor trust with a U.S. grantor or other U.S. owner, generally, the U.S. grantor or other U.S. owner of the grantor trust and not the trust; and
- In the case of a U.S. trust (other than a grantor trust), the U.S. trust (other than a grantor trust) and not the beneficiaries of the trust.

Foreign person. If you are a foreign person or the U.S. branch of a foreign bank that has elected to be treated as a U.S. person, do not use Form W-9. Instead, use the appropriate Form W-8 or Form 8233 (see Publication 515, Withholding of Tax on Nonresident Aliens and Foreign Entities).

Nonresident alien who becomes a resident alien. Generally, only a nonresident alien individual may use the terms of a tax treaty to reduce or eliminate U.S. tax on certain types of income. However, most tax treaties contain a provision known as a "saving clause." Exceptions specified in the saving clause may permit an exemption from tax to continue for certain types of income even after the payee has otherwise become a U.S. resident alien for tax purposes.

If you are a U.S. resident alien who is relying on an exception contained in the saving clause of a tax treaty to claim an exemption from U.S. tax on certain types of income, you must attach a statement to Form W-9 that specifies the following five items:

1. The treaty country. Generally, this must be the same treaty under which you claimed exemption from tax as a nonresident alien.

2. The treaty article addressing the income.

3. The article number (or location) in the tax treaty that contains the saving clause and its exceptions.

4. The type and amount of income that qualifies for the exemption from tax.

5. Sufficient facts to justify the exemption from tax under the terms of the treaty article.

Example. Article 20 of the U.S.-China income tax treaty allows an exemption from tax for scholarship income received by a Chinese student temporarily present in the United States. Under U.S. law, this student will become a resident alien for tax purposes if his or her stay in the United States exceeds 5 calendar years. However, paragraph 2 of the first Protocol to the U.S.-China treaty (dated April 30, 1984) allows the provisions of Article 20 to continue to apply even after the Chinese student becomes a resident alien of the United States. A Chinese student who qualifies for this exception (under paragraph 2 of the first protocol) and is relying on this exception to claim an exemption from tax on his or her scholarship or fellowship income would attach to Form W-9 a statement that includes the information described above to support that exemption.

If you are a nonresident alien or a foreign entity, give the requester the appropriate completed Form W-8 or Form 8233.

Backup Withholding

What is backup withholding? Persons making certain payments to you must under certain conditions withhold and pay to the IRS 28% of such payments. This is called "backup withholding." Payments that may be subject to backup withholding include interest, tax-exempt interest, dividends, broker and barter exchange transactions, rents, royalties, nonemployee pay, payments made in settlement of payment card and third party network transactions, and certain payments from fishing boat operators. Real estate transactions are not subject to backup withholding.

You will not be subject to backup withholding on payments you receive if you give the requester your correct TIN, make the proper certifications, and report all your taxable interest and dividends on your tax return.

Payments you receive will be subject to backup withholding if:

1. You do not furnish your TIN to the requester,

2. You do not certify your TIN when required (see the Part II instructions on page 3 for details),

3. The IRS tells the requester that you furnished an incorrect TIN,

4. The IRS tells you that you are subject to backup withholding because you did not report all your interest and dividends on your tax return (for reportable interest and dividends only), or

5. You do not certify to the requester that you are not subject to backup withholding under 4 above (for reportable interest and dividend accounts opened after 1983 only).

Certain payees and payments are exempt from backup withholding. See *Exempt payee code* on page 3 and the separate Instructions for the Requester of Form W-9 for more information.

Also see *Special rules for partnerships* above.

What is FATCA reporting?

The Foreign Account Tax Compliance Act (FATCA) requires a participating foreign financial institution to report all United States account holders that are specified United States persons. Certain payees are exempt from FATCA reporting. See *Exemption from FATCA reporting code* on page 3 and the Instructions for the Requester of Form W-9 for more information.

Updating Your Information

You must provide updated information to any person to whom you claimed to be an exempt payee if you are no longer an exempt payee and anticipate receiving reportable payments in the future from this person. For example, you may need to provide updated information if you are a C corporation that elects to be an S corporation, or if you no longer are tax exempt. In addition, you must furnish a new Form W-9 if the name or TIN changes for the account; for example, if the grantor of a grantor trust dies.

Penalties

Failure to furnish TIN. If you fail to furnish your correct TIN to a requester, you are subject to a penalty of $50 for each such failure unless your failure is due to reasonable cause and not to willful neglect.

Civil penalty for false information with respect to withholding. If you make a false statement with no reasonable basis that results in no backup withholding, you are subject to a $500 penalty.

Criminal penalty for falsifying information. Willfully falsifying certifications or affirmations may subject you to criminal penalties including fines and/or imprisonment.

Misuse of TINs. If the requester discloses or uses TINs in violation of federal law, the requester may be subject to civil and criminal penalties.

Specific Instructions

Line 1

You must enter one of the following on this line; **do not** leave this line blank. The name should match the name on your tax return.

If this Form W-9 is for a joint account, list first, and then circle, the name of the person or entity whose number you entered in Part I of Form W-9.

a. **Individual.** Generally, enter the name shown on your tax return. If you have changed your last name without informing the Social Security Administration (SSA) of the name change, enter your first name, the last name as shown on your social security card, and your new last name.

Note. ITIN applicant: Enter your individual name as it was entered on your Form W-7 application, line 1a. This should also be the same as the name you entered on the Form 1040/1040A/1040EZ you filed with your application.

b. **Sole proprietor or single-member LLC.** Enter your individual name as shown on your 1040/1040A/1040EZ on line 1. You may enter your business, trade, or "doing business as" (DBA) name on line 2.

c. **Partnership, LLC that is not a single-member LLC, C Corporation, or S Corporation.** Enter the entity's name as shown on the entity's tax return on line 1 and any business, trade, or DBA name on line 2.

d. **Other entities.** Enter your name as shown on required U.S. federal tax documents on line 1. This name should match the name shown on the charter or other legal document creating the entity. You may enter any business, trade, or DBA name on line 2.

e. **Disregarded entity.** For U.S. federal tax purposes, an entity that is disregarded as an entity separate from its owner is treated as a "disregarded entity." See Regulations section 301.7701-2(c)(2)(iii). Enter the owner's name on line 1. The name of the entity entered on line 1 should never be a disregarded entity. The name on line 1 should be the name shown on the income tax return on which the income should be reported. For example, if a foreign LLC that is treated as a disregarded entity for U.S. federal tax purposes has a single owner that is a U.S. person, the U.S. owner's name is required to be provided on line 1. If the direct owner of the entity is also a disregarded entity, enter the first owner that is not disregarded for federal tax purposes. Enter the disregarded entity's name on line 2, "Business name/disregarded entity name." If the owner of the disregarded entity is a foreign person, the owner must complete an appropriate Form W-8 instead of a Form W-9. This is the case even if the foreign person has a U.S. TIN.

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Line 2

If you have a business name, trade name, DBA name, or disregarded entity name, you may enter it on line 2.

Line 3

Check the appropriate box in line 3 for the U.S. federal tax classification of the person whose name is entered on line 1. Check only one box in line 3.

Limited Liability Company (LLC). If the name on line 1 is an LLC treated as a partnership for U.S. federal tax purposes, check the "Limited Liability Company" box and enter "P" in the space provided. If the LLC has filed Form 8832 or 2553 to be taxed as a corporation, check the "Limited Liability Company" box and in the space provided enter "C" for C corporation or "S" for S corporation. If it is a single-member LLC that is a disregarded entity, do not check the "Limited Liability Company" box; instead check the first box in line 3 "Individual/sole proprietor or single-member LLC."

Line 4, Exemptions

If you are exempt from backup withholding and/or FATCA reporting, enter in the appropriate space in line 4 any code(s) that may apply to you.

Exempt payee code.

- Generally, individuals (including sole proprietors) are not exempt from backup withholding.
- Except as provided below, corporations are exempt from backup withholding for certain payments, including interest and dividends.
- Corporations are not exempt from backup withholding for payments made in settlement of payment card or third party network transactions.
- Corporations are not exempt from backup withholding with respect to attorneys' fees or gross proceeds paid to attorneys, and corporations that provide medical or health care services are not exempt with respect to payments reportable on Form 1099-MISC.

The following codes identify payees that are exempt from backup withholding. Enter the appropriate code in the space in line 4.

1—An organization exempt from tax under section 501(a), any IRA, or a custodial account under section 403(b)(7) if the account satisfies the requirements of section 401(f)(2)

2—The United States or any of its agencies or instrumentalities

3—A state, the District of Columbia, a U.S. commonwealth or possession, or any of their political subdivisions or instrumentalities

4—A foreign government or any of its political subdivisions, agencies, or instrumentalities

5—A corporation

6—A dealer in securities or commodities required to register in the United States, the District of Columbia, or a U.S. commonwealth or possession

7—A futures commission merchant registered with the Commodity Futures Trading Commission

8—A real estate investment trust

9—An entity registered at all times during the tax year under the Investment Company Act of 1940

10—A common trust fund operated by a bank under section 584(a)

11—A financial institution

12—A middleman known in the investment community as a nominee or custodian

13—A trust exempt from tax under section 664 or described in section 4947

The following chart shows types of payments that may be exempt from backup withholding. The chart applies to the exempt payees listed above, 1 through 13.

IF the payment is for . . .	THEN the payment is exempt for . . .
Interest and dividend payments	All exempt payees except for 7
Broker transactions	Exempt payees 1 through 4 and 6 through 11 and all C corporations. S corporations must not enter an exempt payee code because they are exempt only for sales of noncovered securities acquired prior to 2012.
Barter exchange transactions and patronage dividends	Exempt payees 1 through 4
Payments over $600 required to be reported and direct sales over $5,000[1]	Generally, exempt payees 1 through 5[2]
Payments made in settlement of payment card or third party network transactions	Exempt payees 1 through 4

[1] See Form 1099-MISC, Miscellaneous Income, and its instructions.

[2] However, the following payments made to a corporation and reportable on Form 1099-MISC are not exempt from backup withholding: medical and health care payments, attorneys' fees, gross proceeds paid to an attorney reportable under section 6045(f), and payments for services paid by a federal executive agency.

Exemption from FATCA reporting code. The following codes identify payees that are exempt from reporting under FATCA. These codes apply to persons submitting this form for accounts maintained outside of the United States by certain foreign financial institutions. Therefore, if you are only submitting this form for an account you hold in the United States, you may leave this field blank. Consult with the person requesting this form if you are uncertain if the financial institution is subject to these requirements. A requester may indicate that a code is not required by providing you with a Form W-9 with "Not Applicable" (or any similar indication) written or printed on the line for a FATCA exemption code.

A—An organization exempt from tax under section 501(a) or any individual retirement plan as defined in section 7701(a)(37)

B—The United States or any of its agencies or instrumentalities

C—A state, the District of Columbia, a U.S. commonwealth or possession, or any of their political subdivisions or instrumentalities

D—A corporation the stock of which is regularly traded on one or more established securities markets, as described in Regulations section 1.1472-1(c)(1)(i)

E—A corporation that is a member of the same expanded affiliated group as a corporation described in Regulations section 1.1472-1(c)(1)(i)

F—A dealer in securities, commodities, or derivative financial instruments (including notional principal contracts, futures, forwards, and options) that is registered as such under the laws of the United States or any state

G—A real estate investment trust

H—A regulated investment company as defined in section 851 or an entity registered at all times during the tax year under the Investment Company Act of 1940

I—A common trust fund as defined in section 584(a)

J—A bank as defined in section 581

K—A broker

L—A trust exempt from tax under section 664 or described in section 4947(a)(1)

M—A tax exempt trust under a section 403(b) plan or section 457(g) plan

Note. You may wish to consult with the financial institution requesting this form to determine whether the FATCA code and/or exempt payee code should be completed.

Line 5

Enter your address (number, street, and apartment or suite number). This is where the requester of this Form W-9 will mail your information returns.

Line 6

Enter your city, state, and ZIP code.

Part I. Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. If you are a resident alien and you do not have and are not eligible to get an SSN, your TIN is your IRS individual taxpayer identification number (ITIN). Enter it in the social security number box. If you do not have an ITIN, see *How to get a TIN* below.

If you are a sole proprietor and you have an EIN, you may enter either your SSN or EIN. However, the IRS prefers that you use your SSN.

If you are a single-member LLC that is disregarded as an entity separate from its owner (see *Limited Liability Company (LLC)* on this page), enter the owner's SSN (or EIN, if the owner has one). Do not enter the disregarded entity's EIN. If the LLC is classified as a corporation or partnership, enter the entity's EIN.

Note. See the chart on page 4 for further clarification of name and TIN combinations.

How to get a TIN. If you do not have a TIN, apply for one immediately. To apply for an SSN, get Form SS-5, Application for a Social Security Card, from your local SSA office or get this form online at *www.ssa.gov*. You may also get this form by calling 1-800-772-1213. Use Form W-7, Application for IRS Individual Taxpayer Identification Number, to apply for an ITIN, or Form SS-4, Application for Employer Identification Number, to apply for an EIN. You can apply for an EIN online by accessing the IRS website at *www.irs.gov/businesses* and clicking on Employer Identification Number (EIN) under Starting a Business. You can get Forms W-7 and SS-4 from the IRS by visiting IRS.gov or by calling 1-800-TAX-FORM (1-800-829-3676).

If you are asked to complete Form W-9 but do not have a TIN, apply for a TIN and write "Applied For" in the space for the TIN, sign and date the form, and give it to the requester. For interest and dividend payments, and certain payments made with respect to readily tradable instruments, generally you will have 60 days to get a TIN and give it to the requester before you are subject to backup withholding on payments. The 60-day rule does not apply to other types of payments. You will be subject to backup withholding on all such payments until you provide your TIN to the requester.

Note. Entering "Applied For" means that you have already applied for a TIN or that you intend to apply for one soon.

Caution: *A disregarded U.S. entity that has a foreign owner must use the appropriate Form W-8.*

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Part II. Certification

To establish to the withholding agent that you are a U.S. person, or resident alien, sign Form W-9. You may be requested to sign by the withholding agent even if items 1, 4, or 5 below indicate otherwise.

For a joint account, only the person whose TIN is shown in Part I should sign (when required). In the case of a disregarded entity, the person identified on line 1 must sign. Exempt payees, see *Exempt payee code* earlier.

Signature requirements. Complete the certification as indicated in items 1 through 5 below.

1. Interest, dividend, and barter exchange accounts opened before 1984 and broker accounts considered active during 1983. You must give your correct TIN, but you do not have to sign the certification.

2. Interest, dividend, broker, and barter exchange accounts opened after 1983 and broker accounts considered inactive during 1983. You must sign the certification or backup withholding will apply. If you are subject to backup withholding and you are merely providing your correct TIN to the requester, you must cross out item 2 in the certification before signing the form.

3. Real estate transactions. You must sign the certification. You may cross out item 2 of the certification.

4. Other payments. You must give your correct TIN, but you do not have to sign the certification unless you have been notified that you have previously given an incorrect TIN. "Other payments" include payments made in the course of the requester's trade or business for rents, royalties, goods (other than bills for merchandise), medical and health care services (including payments to corporations), payments to a nonemployee for services, payments made in settlement of payment card and third party network transactions, payments to certain fishing boat crew members and fishermen, and gross proceeds paid to attorneys (including payments to corporations).

5. Mortgage interest paid by you, acquisition or abandonment of secured property, cancellation of debt, qualified tuition program payments (under section 529), IRA, Coverdell ESA, Archer MSA or HSA contributions or distributions, and pension distributions. You must give your correct TIN, but you do not have to sign the certification.

What Name and Number To Give the Requester

For this type of account:	Give name and SSN of:
1. Individual	The individual
2. Two or more individuals (joint account)	The actual owner of the account or, if combined funds, the first individual on the account[1]
3. Custodian account of a minor (Uniform Gift to Minors Act)	The minor[2]
4. a. The usual revocable savings trust (grantor is also trustee)	The grantor-trustee[1]
b. So-called trust account that is not a legal or valid trust under state law	The actual owner[1]
5. Sole proprietorship or disregarded entity owned by an individual	The owner[3]
6. Grantor trust filing under Optional Form 1099 Filing Method 1 (see Regulations section 1.671-4(b)(2)(i)(A))	The grantor*
For this type of account:	**Give name and EIN of:**
7. Disregarded entity not owned by an individual	The owner
8. A valid trust, estate, or pension trust	Legal entity[4]
9. Corporation or LLC electing corporate status on Form 8832 or Form 2553	The corporation
10. Association, club, religious, charitable, educational, or other tax-exempt organization	The organization
11. Partnership or multi-member LLC	The partnership
12. A broker or registered nominee	The broker or nominee
13. Account with the Department of Agriculture in the name of a public entity (such as a state or local government, school district, or prison) that receives agricultural program payments	The public entity
14. Grantor trust filing under the Form 1041 Filing Method or the Optional Form 1099 Filing Method 2 (see Regulations section 1.671-4(b)(2)(i)(B))	The trust

[1] List first and circle the name of the person whose number you furnish. If only one person on a joint account has an SSN, that person's number must be furnished.

[2] Circle the minor's name and furnish the minor's SSN.

[3] You must show your individual name and you may also enter your business or DBA name on the "Business name/disregarded entity" name line. You may use either your SSN or EIN (if you have one), but the IRS encourages you to use your SSN.

[4] List first and circle the name of the trust, estate, or pension trust. (Do not furnish the TIN of the personal representative or trustee unless the legal entity itself is not designated in the account title.) Also see *Special rules for partnerships* on page 2.

***Note.** Grantor also must provide a Form W-9 to trustee of trust.

Note. If no name is circled when more than one name is listed, the number will be considered to be that of the first name listed.

Secure Your Tax Records from Identity Theft

Identity theft occurs when someone uses your personal information such as your name, SSN, or other identifying information, without your permission, to commit fraud or other crimes. An identity thief may use your SSN to get a job or may file a tax return using your SSN to receive a refund.

To reduce your risk:

- Protect your SSN,
- Ensure your employer is protecting your SSN, and
- Be careful when choosing a tax preparer.

If your tax records are affected by identity theft and you receive a notice from the IRS, respond right away to the name and phone number printed on the IRS notice or letter.

If your tax records are not currently affected by identity theft but you think you are at risk due to a lost or stolen purse or wallet, questionable credit card activity or credit report, contact the IRS Identity Theft Hotline at 1-800-908-4490 or submit Form 14039.

For more information, see Publication 4535, Identity Theft Prevention and Victim Assistance.

Victims of identity theft who are experiencing economic harm or a system problem, or are seeking help in resolving tax problems that have not been resolved through normal channels, may be eligible for Taxpayer Advocate Service (TAS) assistance. You can reach TAS by calling the TAS toll-free case intake line at 1-877-777-4778 or TTY/TDD 1-800-829-4059.

Protect yourself from suspicious emails or phishing schemes. Phishing is the creation and use of email and websites designed to mimic legitimate business emails and websites. The most common act is sending an email to a user falsely claiming to be an established legitimate enterprise in an attempt to scam the user into surrendering private information that will be used for identity theft.

The IRS does not initiate contacts with taxpayers via emails. Also, the IRS does not request personal detailed information through email or ask taxpayers for the PIN numbers, passwords, or similar secret access information for their credit card, bank, or other financial accounts.

If you receive an unsolicited email claiming to be from the IRS, forward this message to *phishing@irs.gov*. You may also report misuse of the IRS name, logo, or other IRS property to the Treasury Inspector General for Tax Administration (TIGTA) at 1-800-366-4484. You can forward suspicious emails to the Federal Trade Commission at: *spam@uce.gov* or contact them at *www.ftc.gov/idtheft* or 1-877-IDTHEFT (1-877-438-4338).

Visit IRS.gov to learn more about identity theft and how to reduce your risk.

Privacy Act Notice

Section 6109 of the Internal Revenue Code requires you to provide your correct TIN to persons (including federal agencies) who are required to file information returns with the IRS to report interest, dividends, or certain other income paid to you; mortgage interest you paid; the acquisition or abandonment of secured property; the cancellation of debt; or contributions you made to an IRA, Archer MSA, or HSA. The person collecting this form uses the information on the form to file information returns with the IRS, reporting the above information. Routine uses of this information include giving it to the Department of Justice for civil and criminal litigation and to cities, states, the District of Columbia, and U.S. commonwealths and possessions for use in administering their laws. The information also may be disclosed to other countries under a treaty, to federal and state agencies to enforce civil and criminal laws, or to federal law enforcement and intelligence agencies to combat terrorism. You must provide your TIN whether or not you are required to file a tax return. Under section 3406, payers must generally withhold a percentage of taxable interest, dividend, and certain other payments to a payee who does not give a TIN to the payer. Certain penalties may also apply for providing false or fraudulent information.

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DSBO FORMS

The DSBO forms which apply to this contract are contained in the pages immediately following this page. These pages are not included in the numbering of this contract document.

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DENVER
OFFICE OF ECONOMIC DEVELOPMENT

COMMITMENT TO MWBE PARTICIPATION

Office of Economic Development
Division of Small Business Opportunity
Denver International Airport
Jeppesen Terminal, Level 6, West
8500 Pena Blvd
Denver, CO 80249
Phone: 303-342-2187
DSBO@flydenver.com

The undersigned has satisfied the MWBE participant requirements in the following manner (Please check the appropriate box):

☐ The Bidder/Proposer is committed to the minimum _____% **MWBE** utilization on the project, and will submit Letters of Intent (LOI) for each subcontractor/subconsultant listed in the Bid Forms as follows:
Hard Bids: **Three (3)** business days after the bid opening.
Request for Proposals/Qualifications: With the proposal when due.
Compliance Plans: With each task/work order

☐ The Bidder/Proposer is unable to meet the project goal of _____% **MWBE,** but is committed to a minimum of _____% **MWBE** utilization on the project. The Bidder/Proposer understands that they must submit a detailed statement of their good faith effort under sealed bid procedures, as a matter of responsiveness, or with initial proposals, under contract negotiation procedures; or no later than **three (3)** days after bid opening as a matter of responsibility as in accordance with DRMC Section 28-62 and 28-67 of Ordinance 85 to the Division of Small Business Opportunity.

☐ The Bidder/Proposer is a certified **MWBE** in good standing with the City and is committed to self-perform a minimum of _____% of the work on the contract.

Bidder/Proposer (Name of Firm):			
Firm's Representative (Please print):			
Signature (Firm's Representative):			
Title:			
Address:			
City:		State:	Zip:
Phone:	Fax:	Email:	

A copy of the MWBE Certification letter must be attached to each Letter of Intent (LOI).

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List of Proposed M/WBE Proposers, Subcontractors, Suppliers (Manufacturers) or Brokers

Office of Economic Development
Division of Small Business Opportunity
Denver International Airport
Main Terminal, Level 6
8500 Pena Blvd
Denver, CO 80249
Phone: 303-342-2180
EMAIL: DSBO@flydenver.com

City and County of Denver Contract No.:_____

The undersigned proposes to utilize the following M/WBE for the project. All listed firms are **CURRENTLY** certified by the City and County of Denver. Only the level of M/WBE participation listed at the bid opening will count toward satisfaction of the project goal. Only bona fide commisions may be counted for Brokers. M/WBE prime proposers must detail their bid information below. Please copy and attach this page to list additional M/WBE.

Address:	Contact Person:	
Type of Service:	Dollar Amount: $:	Percent of Project:

M/WBE Prime Proposer

Business Name:		
Address:	Contact Person:	
Type of Service:	Dollar Amount: $:	Percent of Project:

Subcontractors, Suppliers Manufacturers or Brokers (check one box)

	Subcontractor (√)		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:				Type of Service:			
Contact Person:				Dollar Amount: $:		Percent of Project:	
	Subcontractor (√)		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:				Type of Service:			
Contact Person:				Dollar Amount: $:		Percent of Project:	
	Subcontractor (√)		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:				Type of Service:			
Contact Person:				Dollar Amount: $:		Percent of Project:	

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Subcontractors, Suppliers Manufacturers or Brokers (check one box)							
	Subcontractor (√)		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:				Type of Service:			
Contact Person:				Dollar Amount: $:		Percent of Project:	
	Subcontractor (√)		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:				Type of Service:			
Contact Person:				Dollar Amount: $:		Percent of Project:	
	Subcontractor (√)		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:				Type of Service:			
Contact Person:				Dollar Amount: $:		Percent of Project:	
	Subcontractor (√)		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:				Type of Service:			
Contact Person:				Dollar Amount: $:		Percent of Project:	
	Subcontractor (√)		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:				Type of Service:			
Contact Person:				Dollar Amount: $:		Percent of Project:	
	Subcontractor (√)		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:				Type of Service:			
Contact Person:				Dollar Amount: $:		Percent of Project:	
	Subcontractor (√)		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:				Type of Service:			
Contact Person:				Dollar Amount: $:		Percent of Project:	

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DENVER
OFFICE OF ECONOMIC DEVELOPMENT

Office of Economic Development
Division of Small Business Opportunity
Denver International Airport
Jeppesen Terminal, Level 6, West
Denver, CO 80249
Phone: 303-342-2187

LETTER OF INTENT (LOI)

INSTRUCTIONS FOR COMPLETION & SUBMISSION:

- *All lines must be completed or marked N/A for Not Applicable*
- *Certification Letter must be submitted with LOI*
- *Submit the attached completed checklist with this letter*
- *Email to dsbo@flydenver.com,*
- ***FOR RFPs and RFQs: LOIs should be included with Submittal***

Contract No.:	**Project Name:**

A. The Following Section is to Be Completed by the Bidder/Consultant
This Letter of Intent Must be Signed by the Bidder/Consultant and MWBE, SBE, EBE or DBE

Name of Bidder/Consultant:	Self-Performing: ☐ Yes ☐ No	Phone:	
Contact Person:	Email:	Fax:	
Address:	City:	State:	Zip:

B. The Following Section is To Be Completed by the MWBE, SBE, EBE or DBE, at any Tier
This Letter of Intent Must be Signed by the MWBE, SBE, EBE or DBE and Bidder/Consultant

Name of Certified Firm:		Phone:	
Contact Person:	Email:	Fax:	
Address:	City:	State:	Zip:

Please check the designation which applies to the certified firm.	**MWBE (√)**		**SBE (√)**		**EBE (√)**		**DBE (√)**	

Indirect Utilization: If this MWBE, SBE, EBE or DBE is not a direct first tier subcontractor/subconsultant, supplier or broker to the Bidder/ Consultant, please indicate the name of the subcontractor/subconsultant, supplier or broker which is utilizing the participation of this firm:

A Copy of the MWBE, SBE, EBE or DBE Letter of Certification must be Attached

Identify the scope of the work to be performed or supply item that will be provided by the MWBE/SBE/DBE. **On unit price bids only, identify which bid line items the MWBE/SBE/EBE/DBEs scope of work or supply corresponds to.**

	Subcontractor/Subconsultant (√)		**Supplier (√)**		**Broker (√)**

Bidder intends to utilize the aforementioned MWBE, SBE, EBE or DBE for the Work/Supply described above. The cost of the work and percentage of the total subcontractor MWBE, SBE, EBE or DBE bid amount is:

$	**%**
Consultant intends to utilize the aforementioned MWBE, SBE, EBE or DBE for the Work/Supply described above. The percentage of the work of the total sub consultant MWBE, SBE, EBE or DBE will perform is:	%
If the fee amount of the work to be performed is requested, the fee amount, is:	$

Bidder/Consultant's Signature:	Date:
Title:	
MWBE, SBE, EBE or DBE or Self-Performing Firm's Signature:	Date:
Title:	

If the above-named Bidder/Consultant is not determined to be the successful Bidder/Consultant, this **Letter of Intent** shall be null and void.

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Letter of Intent (LOI) Checklist

All lines must be completed or marked N/A for Not Applicable

Submit the attached completed checklist with this letter.

Completed ✓	
☐	Project Number & Project Name
☐	**Section A**: Name of Bidder/Consultant, Contact Person, Address, City, State, Zip, Phone, Email
☐	**Section B**: Name of Certified Firm, Contact Person, Address, City, State, Zip, Phone, Email
☐	Designation checked for MBE/WBE, SBE, EBE or DBE
☐	**Indirect Utilization:** Name of subcontractor/subconsultant, supplier or broker is indicated if using the participation of a 2nd tier subcontractor/subconsultant, supplier or broker.
☐	Scope of work performed, or item supplied by MWBE, SBE, EBE or DBE
☐	Line items performed, if line-item bid.
☐	Copy of MWBE, SBE, EBE or DBE Letter of Certification Attached
☐	Designation checked for Subcontractor/Subconsultant, Supplier or Broker
	If project is a hard bid…
☐	Bidder has indicated dollar amount for value of work going to Subcontractor/ Subconsultant, Supplier or Broker
☐	Bidder has indicated percentage for value of work going to Subcontractor/ Subconsultant, Supplier or Broker
	If project is an RFP/RFQ…
☐	Consultant has indicated percentage for value of work going to Subcontractor/ Subconsultant, Supplier or Broker Name & contact name for MWBE.
☐	Fee amount if fee amount of work to be performed is requested.
☐	Bidder/Consultant's Signature, Title & Date
☐	MWBE, SBE, EBE or DBE Firm's Signature, Title and Date

Select One ✓	**SUBMITTED VIA… For Construction Hard Bids ONLY, Bidders are strongly urged to deliver the LOI via one of the methods below. (The preferred method is to scan/email completed forms to email address below. Delivery to any other point cannot be guaranteed timely delivery.)**
☐	Email to DSBO@flydenver.com

The complete and accurate information that is required for the Letter of Intent is based on the following sections of the Ordinance 85: Section 28-63 and Section 28-68. Failure to complete this information on the Letter of Intent (LOI) may automatically deem a bid or proposal non-responsive.

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DENVER
OFFICE OF ECONOMIC DEVELOPMENT

JOINT VENTURE ELIGIBILITY FORM

Office of Economic Development
Division of Small Business Opportunity
Denver International Airport
Jeppesen Terminal, Level 6, West
Denver, CO 80249
Phone: 303-342-2187
DSBO@flydenver.com

Joint Venture means an association of two (2) or more business enterprises to constitute a single business enterprise to perform a City construction or professional design and construction services contract for which purpose they combine their property, capital, efforts, skills and knowledge, and in which each joint venturer is responsible for a distinct, clearly defined portion of the work of the contract, performs a commercially useful function, and whose share in the capital contribution, control, management responsibilities, risks and profits of the joint venture are equal to its ownership interest. Joint ventures must have an agreement in writing specifying the terms and conditions of the relationships between the joint venturers and their relationship and responsibility to the contract.

The Division of Small Business Opportunity (DSBO) requires the following information be provided from participants of a prospective joint venture, to assist DSBO in evaluating the proposed joint venture. This Joint Venture Eligibility form and the Joint Venture Affidavit apply if SBEs, EBEs, MBEs, WBEs or DBEs participate in this joint venture.

Please return this form, the Joint Venture Affidavit, and a copy of your Joint Venture Agreement to: Division of Small Business Opportunity, 201 West Colfax Avenue, Denver, CO 80202, at least **ten (10) working days** prior to bid opening or proposal.

If you have questions regarding this process, please contact DSBO at 303-342-2187.

Joint Venture Information

Name:		Contact Person:	
Address:			
City:	State:	Zip:	Phone:

Joint Venture Participants

Name:		Contact Person:	
Address:			
City:	State:	Zip:	Phone:
% Ownership:	Certifying Entity:	Type Certification & Date: (S/E/M/W or DBE)	
Type of Work for which Certification was granted:			
Name:		Contact Person:	
Address:			
City:	State:	Zip:	Phone:
% Ownership:	Certifying Entity:	Type Certification & Date: (S/E/M/W or DBE)	
Type of Work for which Certification was granted:			

General Information

SBE/EBE/MBE/WBE/DBE Initial Capital Contributions: $ %

Future capital contributions (explain requirements) (attach additional sheets if necessary):

Source of Funds for the SBE/EBE/MBE/WBE/DBE Capital Contributions:

Describe the portion of the work or elements of the business controlled by the SBE/EBE/MBE/WBE or DBE: (attach additional sheets if necessary)

Describe the portion of the work or elements of the business controlled by non-SBE/EBE/MBE/WBE or DBE: (attach additional sheets if necessary)

JOINT VENTURE ELIGIBILITY FORM

General information

Describe the SBE/EBE/MBE/WBE or DBE's involvement in the overall management of the joint venture (e.g., participation on a management committee or managing board voting rights, etc.) (attach additional sheets if necessary)

Describe the SBE/EBE/MBE/WBE or DBE's share in the profits of the joint venture:

Describe the SBE/EBE/MBE/WBE or DBE's share in the risks of the joint venture:

Describe their roles and responsibilities of each joint venture participant with respect to managing the joint venture (use additional sheets if necessary):

a. SBE/EBE/MBE/WBE or DBE joint venture participant:

b. Non- SBE/EBE/MBE/WBE or DBE joint venture participant:

Describe the roles and responsibilities of each joint venture participant with respect to operation of the joint venture (use additional sheets if necessary):

a. SBE/EBE/MBE/WBE or DBE joint venture participant:

b. Non- SBE/EBE/MBE/WBE or DBE joint venture participant:

Which firm will be responsible for accounting functions relative to the joint venture's business?

Explain what authority each party will have to commit or obligate the other to insurance and bonding companies, financing institutions, suppliers, subcontractors, and/or other parties?

Please provide information relating to the approximate **number** of management, administrative, support and non-management employees that will be required to operate the business and indicate whether they will be employees of the S/E/MWBE/DBE, non- S/E/MWBE/DBE or joint venture:

	Non- SBE/EBE/M/WBE/DBE	SBE/EBE/M/WBE/DBE	Joint Venture
Management			
Administrative			
Support			
Hourly Employees			

JOINT VENTURE ELIGIBILITY FORM

General Information

Please provide the name of the person who will be responsible for hiring employees for the joint venture.

Who will they be employed by?

Are any of the proposed joint venture employees currently employees of any of the joint venture partners?		Yes (√)		No (√)

If yes, please list the number and positions and indicate which firm currently employs the individual(s), (use additional sheets if necessary)

Number of employees		**Position**	**Employed By**

Attach a copy of the proposed joint venture agreement, promissory note or loan agreement (if applicable), and any and all written agreements between the joint venture partners.

List all other business relationships between the joint venture participants, including other joint venture agreements in which the parties are jointly involved.

If there are any significant changes in or pertaining to this submittal, the joint venture members must immediately notify the Division of Small Business Opportunity.

COMP-FRM-015

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DENVER
OFFICE OF ECONOMIC DEVELOPMENT

Joint Venture Affidavit

Office of Economic Development
Division of Small Business Opportunity
Denver International Airport
Jeppesen Terminal, Level 6, West
Denver, CO 80249
Phone: 303-342-2187
DSBO@flydenver.com

The Undersigned swears that the foregoing statements are correct and include all material information necessary to identify and explain the terms and operation of our joint venture and the intended participation by each joint venturer in the undertaking. Further, the Undersigned covenant and agree to provide the City current, complete, and accurate information regarding actual joint venture work and the payment thereof and any proposed changes in any of the joint venture arrangements and to permit the audit and examination of the books, records, and files of the joint venture, by authorized representatives of the City or Federal funding agency, if applicable. Any material misrepresentation will be grounds for terminating any contract which may be awarded and for initialing action under Federal or State laws concerning false statements.

Name of Firm:

Print Name:	Title
Signature:	Date:

Notary Public

County of	State of	My Commission Expires:

Subscribed and sworn before me this

_____ day of _____, 20____

_____

Notary Signature: _____

_____

Notary Commission #: _____

_____

Address: _____

_____

Notary Seal

Name of Firm:

Print Name:	Title
Signature:	Date:

Notary Public

County of	State of	My Commission Expires:

Subscribed and sworn before me this

_____ day of _____, 20____

_____

Notary Seal

DocuSign Envelope ID: 1EA62A39-CE90-42C1-BFBD-1453DA4489DB

Notary Commission #: _____

Address: _____

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INSURANCE CERTIFICATE OR REQUIREMENTS

The insurance requirements relative to this contract are contained in the pages immediately following this page.

These pages are not included in the numbering of this contract document.

Reference: DEN ROCIP III Safety Manual
DEN ROCIP III Insurance Manual
DEN ROCIP III Claims Guide

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_____

DENVER INTERNATIONAL AIRPORT
Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Bond

KNOW ALL MEN BY THESE PRESENTS

THAT _____ as Principal, and _____ _____, a corporation organized and existing under and by virtue of the laws of the State of _____, and authorized to do business within the State of Colorado as Surety, are held and firmly bound unto the City and County of Denver, Colorado, as Obligee, in the full and just sum of _____ _____ Dollars and _____ Cents ($_____) lawful money of the United States, for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents:

WHEREAS, the said Principal is herewith submitting its Bid, dated on _____ _____, _____ for the construction of Contract No. 201951778, Concourse A & C Pre-Conditioned Air Re-Life, Denver International Airport, as set forth in detail in the contract documents for the City and County of Denver, Colorado, and said Obligee has required as a condition for receiving said Bid that the Principal deposit specified bid security in the amount of not less than five percent (5%) of the amount of said Bid, as it relates to work to be performed for the City, conditioned that in event of failure of the Principal to execute the Contract for such construction and furnish required Performance and Payment Bond if the Contract is offered him, that said sum be paid immediately to the Obligee as liquidated damages, and not as a Penalty, for the Principal's failure to perform.

The condition of this obligation is such that if the aforesaid Principal shall, within the period specified therefor, on the prescribed form presented to him for signature, enter into a written Contract with the Obligee in accordance with his bid as accepted, and give Performance and Payment Bond with good and sufficient surety or sureties, upon the form prescribed by the Obligee, for the faithful performance and the proper fulfillment of said Contract, or in the event of withdrawal of said bid within the time specified, or upon the payment to the Obligee of the sum determined upon herein, as liquidated damages and not as a Penalty, in the event the Principal fails to enter into said Contract and give such Performance and Payment Bond within the time specified, then this Obligation shall be null and void, otherwise to remain in full force and effect.

[END OF PAGE]

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

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 Excluded Parties under the definitions Section 7 for a general list of excluded parties. 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 the DEN ROCIP. These manuals are part of the Contract Documents.

DEN ROCIP Insurance Manual
DEN ROCIP Safety Manual

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

Contractor and subcontractors of any tier shall require all Excluded Parties, as defined in Section 7 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) must be emailed in pdf format to: contractadmininvoices@flydenver.com
- HARD COPIES of certificates and/or copies of insurance policies will not be accepted.
- ACORD FORM (or equivalent) must reference the DEN assigned Contract Number.

2.3 Coverage and Limits

2.3.1 Commercial General Liability

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Contractor shall maintain insurance coverage including bodily injury, property damage, personal injury, advertising injury, and products and completed operations in minimum limits of $1,000,000 each occurrence, $2,000,000 products and completed operations aggregate and $2,000,000 policy and project/location aggregate.

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.

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, then a schedule of insured vehicles (including year, make, model and VIN number) must be submitted by the insurer with the Certificate of Insurance.

2.3.2.3 The policy must not contain an exclusion related to operations on airport premises.

2.3.2.4 If transporting waste, hazardous material, or regulated substances, Contractor shall carry a Broadened Pollution Endorsement and an MCS 90 endorsement on its policy.

2.3.2.5 If Contractor is an individual or represents that Contractor does not own any motor vehicles and Contractor's owners, officers, directors, and employees use their personal vehicles for business purposes, Personal Automobile Liability insurance coverage will be accepted provided it includes a business use endorsement.

2.3.2.6 If Contractor will be completing all services to DEN under this Agreement remotely this requirement will be 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 If Contractor is a sole proprietor, Workers' Compensation and Employer's Liability is exempt under the Colorado Workers' Compensation Act.

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 [Exhibit A].

2.3.5 Contractor's Pollution Legal Liability

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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.

2.3.6 Technology Errors and Omissions, Network Security, and Privacy Liability (Cyber):

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.

2.3.6.1 Coverage shall include professional misconduct or lack of ordinary skill for those positions defined in [Exhibit A] of this Agreement.

2.3.6.2 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.

2.3.7 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:

2.3.7.1 Express written permission must be granted by DEN.

2.3.7.2 Express written permission must be granted by the Federal Aviation Administration (FAA).

2.3.7.3 Drone equipment must be properly registered with the FAA.

2.3.7.4 Drone operator(s) must be properly licensed by the FAA.

2.3.7.5 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

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single limit each occurrence for bodily injury and property damage.

2.3.8 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), 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, 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.

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 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 or 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, and in any event, 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.

2.8 Additional Provisions

2.8.1 Deductibles, SIRS, or any other type of retention are the sole responsibility of the policyholder.
2.8.2 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.
2.8.3 A severability of interests or separation of insureds provision (no insured vs. insured exclusion) is included.

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2.8.4 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.

2.8.5 Coverage limits purchased by Contractor greater than the minimum amounts required under this Agreement must be referenced on any provided certificate of insurance and extended to the benefit of the City.

2.8.6 All policies shall be written on an occurrence form when available. If an occurrence form is unavailable, 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.

2.8.7 Contractor shall advise DEN in the event any general aggregate or other aggregate limits are reduced below the required per occurrence limits. At their own expense, and where such general aggregate or other aggregate limits have been reduced below the required per occurrence limit, the Contractor will procure such per occurrence limits and furnish a new certificate of insurance showing such coverage is in force.

2.8.8 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 a person authorized by the insurer to bind coverage on its behalf and must be submitted to DEN at the time Contractor signed this Agreement.

2.8.9 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.

2.8.10 Certificate of Insurance and Related Endorsements: DEN's acceptance of a certificate of insurance or other proof of insurance that does not comply with all insurance requirements set forth in this Agreement shall not act as a waiver of Contractor's breach of this Agreement or of any of DEN's rights or remedies under this Agreement. DEN's acceptance of any submitted insurance certificate is subject to the approval of DEN Risk Management. All coverage requirements specified in the certificate 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 herein.

2.8.11 DEN shall have the right to verify or confirm, at any time, all coverage, information or representations, and the insured and its undersigned agent shall promptly and fully cooperate in any such audit DEN may elect to undertake including provision of certified copies of insurance policies upon request.

2.8.12 No material changes that negatively impact DEN or reductions in the coverage required herein shall be allowed without the review and written approval of 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 Excluded Parties (as defined in Section 7). Participation is mandatory but not

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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 Section 3.8 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)	$8,000,000
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

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Annual General Aggregate (Per Project and Reinstates Annually)	$200,000,000
Products/Completed Operations Aggregate (Per Project)	$200,000,000
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 $500,000,000 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

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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 Chargebacks

3.8.2.1 Commercial General Liability Insurance Claim Chargeback

A claim charge-back will be assessed for the amount of any loss payable under the DEN ROCIP Commercial General Liability Policy. The Enrolled Party primarily responsible for causing any bodily injury or property damage liability loss shall be responsible for payment of the charge-back. The determination of responsibility will be solely determined by DEN. The charge-back will be calculated as follows:

Maximum Chargeback	Equal to the deductible under the Enrolled Party's Commercial General Liability Policy (non-ROCIP) up to a maximum of $25,000 each claim.
Minimum Chargeback	Equal to the actual loss or $5,000, whichever is less.

3.8.2.2 Contractor's Pollution Liability Insurance Claim Chargeback

A claim charge-back will be assessed for the amount of any loss payable under the Contractor's Pollution Liability Policy. Up to the first $5,000 of any loss will be paid by Contractor. This includes all expenses or claim payments incurred by the ROCIP insurer for losses attributable to the Contractor's work, acts or omissions, or the Work, or acts or omissions of any tier of subcontractor. Contractor may elect to pass this charge through to any responsible subcontractor but in no event may require total subcontractor reimbursement in excess of $5,000.

3.8.2.3 Builder's Risk Insurance Claim Chargeback

A claim charge-back will be assessed for the amount of any loss payable under the Builder's Risk Insurance Policy. Up to the first $5,000 of any loss will be paid by Contractor. This includes all expenses or claim payments incurred by the insurer for losses attributable to the Contractor's work, acts or omissions, or the Work, or acts or omissions of any tier of subcontractor. Contractor may elect to pass this charge through to any responsible subcontractor but in no event may require total subcontractor reimbursement in excess of $5,000.

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.

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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 Arthur J. Gallagher RMS, Inc.
12444 Powerscourt Drive
St. Louis, MO 63131
Attn: Gallagher OCIP Group

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) must be emailed in pdf format to: contractadmininvoices@flydenver.com and heather_lawson@ajg.com
- HARD COPIES of certificates and/or copies of insurance policies will not be accepted.
- ACORD FORM (or equivalent) must reference the DEN assigned Contract Number.

3.9.3 Commercial General Liability – Off Site Only

Contractor shall maintain insurance coverage including bodily injury, property damage, personal injury, advertising injury, and products and completed operations for Contract operations not physically occurring within the Project Site in minimum limits of $1,000,000 each occurrence, $2,000,000 products and completed operations aggregate and $2,000,000 policy and project/location aggregate.

3.9.3.1 Coverage shall include Contractual Liability covering liability assumed under this Agreement (including defense costs assumed under contract) within the scope of coverages provided.

3.9.4 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.

3.9.4.1 If operating vehicles unescorted airside at DEN, a $10,000,000 combined single limit each occurrence for bodily injury and property damage is required.

3.9.4.2 If Contractor does not have blanket coverage on all owned and operated vehicles, then a schedule of insured vehicles (including year, make, model and VIN number) must be submitted by the insurer with the Certificate of Insurance.

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3.9.4.3 The policy must not contain an exclusion related to operations on airport premises.

3.9.4.4 If transporting waste, hazardous material, or regulated substances, Contractor shall carry a pollution coverage endorsement and an MCS 90 endorsement on its policy.

3.9.4.5 If Contractor is an individual or represents that Contractor does not own any motor vehicles and Contractor's owners, officers, directors, and employees use their personal vehicles for business purposes, Personal Automobile Liability insurance coverage will be accepted provided it includes a business use endorsement.

3.9.4.6 If Contractor will be completing all services to DEN under this Agreement remotely this requirement will be waived.

3.9.5 Workers' Compensation and Employer's Liability Insurance – Off Site Only

Coverage to protect Contractor/Subcontractor from and against all claims arising from performance of Work outside the Project Site under the Contract.

Contractor shall maintain the coverage as required by statute for performance of Work outside the Project Site under the Contract 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.

3.9.5.1 If Contractor is a sole proprietor, Workers' Compensation and Employer's Liability is exempt under the Colorado Workers'' Compensation Act.

3.9.6 Professional Liability (Errors and Omissions) Insurance [REMOVE IF NOT PERTINENT PER SOW.]

Contractor shall maintain a minimum limit of $1,000,000 each claim and policy aggregate, providing coverage for applicable services outlined in [Exhibit A].

3.9.7 Technology Errors and Omissions, Network Security, and Privacy Liability (Cyber): [REMOVE IF NOT PERTINENT PER SOW.]

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.

3.9.7.1 Coverage shall include professional misconduct or lack of ordinary skill for those positions defined in [Exhibit A] of this Agreement.

3.9.7.2 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.

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3.9.8 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.

3.9.9 Reference to Project and/or Contract

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

3.9.10 Additional Insured

For all coverages required under this Agreement (excluding Workers' Compensation, Technology Errors and Omissions, Network Security, and Privacy Liability (Cyber) and Professional Liability) 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.

3.9.11 Waiver of Subrogation

For all coverages required under this Agreement, 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.

3.9.12 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 coverage from the requirements herein before the expiration date thereof.

3.9.12.1 Such notice shall reference the DEN assigned contract number related to this Agreement.

3.9.12.2 Said notice shall be sent thirty (30) days prior to such cancellation or non-renewal or reduction in coverage unless due to non-payment of premiums for which notice shall be sent ten (10) days prior.

3.9.12.3 If such written notice is unavailable from the insurer, and in any event, 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.

3.9.13 Additional Provisions

3.9.13.1 Deductibles, SIRS, or any other type of retention are the sole responsibility of the policyholder.

3.9.13.2 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.

3.9.13.3 A severability of interests or separation of insureds provision (no insured vs.

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insured exclusion) is included.

3.9.13.4 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.

3.9.13.5 Coverage limits purchased by Contractor greater than the minimum amounts required under this Agreement must be referenced on any provided certificate of insurance.

3.9.13.6 All policies shall be written on an occurrence form. If an occurrence form is unavailable, 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.

3.9.13.7 Contractor shall advise DEN in the event any general aggregate or other aggregate limits are reduced below the required per occurrence limits. At their own expense, and where such general aggregate or other aggregate limits have been reduced below the required per occurrence limit, the Contractor will procure such per occurrence limits and furnish a new certificate of insurance showing such coverage is in force.

3.9.13.8 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 a person authorized by the insurer to bind coverage on its behalf and must be submitted to DEN at the time Contractor signed this Agreement.

3.9.13.9 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.

3.9.13.10 Certificate of Insurance and Related Endorsements: DEN's acceptance of a certificate of insurance or other proof of insurance that does not comply with all insurance requirements set forth in this Agreement shall not act as a waiver of Contractor's breach of this Agreement or of any of DEN's rights or remedies under this Agreement. DEN's acceptance of any submitted insurance certificate is subject to the approval of DEN Risk Management. All coverage requirements specified in the certificate 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 herein.

3.9.13.11 DEN shall have the right to verify or confirm, at any time, all coverage, information or representations, and the insured and its undersigned agent shall promptly and fully cooperate in any such audit DEN may elect to undertake including provision of certified copies of insurance policies upon request.

3.9.13.12 No material changes that negatively impact DEN or reductions in the coverage required herein shall be allowed without the review and written approval of DEN Risk Management.

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.

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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

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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,

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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.

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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.
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:

(1) Any person or organization that fabricates or manufactures products, materials or supplies away from the Project Site(s) with no direct onsite installation responsibility;

(2) Hazardous materials remediation, removal, or transportation companies and their consultants;

(3) Any architect, engineer or surveyor and their consultants except when approved by DEN and its insurer(s);

(4) 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 the Site;

(5) Contractors and their subcontractors and subconsultants and any employee of an Enrolled Party, who does not work at the Project Site;

(6) Any employees of an Enrolled Party who occasionally visits the Project Site to make deliveries, pick-up supplies or personnel, to perform supervisory or progress inspections, or for any other reason; however, employees making deliveries to the Project Site for the purposes of off-loading material may be eligible for coverage under the DEN ROCIP.

(7) Persons or entities who are not Enrolled Parties or included as insureds within the policies;

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(8) Any Day Labor Employees (labor service employees whose coverage is provided by their employer); or

(9) Any other person or entity specifically excluded by DEN, in its sole discretion, from participation as Enrolled Parties.

10) Any other person or entity specifically excluded by DEN, in its sole discretion, from participation as Enrolled Parties.

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.

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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.

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Signed, sealed and delivered this _____ day of _____, _____

Attest:

_____ _____

Secretary PRINCIPAL

[SEAL if bidder a corporation]

By:_____

President

_____

SURETY

By:_____

Attorney-in-Fact

(ATTACH POWER OF ATTORNEY)

Power of Attorney shall be certified as to the date of bid.

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CITY AND COUNTY OF DENVER
DEPARTMENT OF AVIATION
NOTICE TO APPARENT LOW BIDDER

Date: [Date]

To: [Bidder name and address]

The Chief Executive Officer, having considered the Bids submitted for the construction of Contract No. 201951778, Concourse A & C Pre-Conditioned Air Re-Life, Denver International Airport, as set forth in detail in the Contract Documents for the City and County of Denver, Colorado and it appearing that your Bid is fair, equitable and in the best interest of said City and County, the said Bid with a Total Contract Bid Amount of _____Dollars ($_____) is hereby declared to be acceptable, subject to the approval of the execution of the contract by the City in accordance with the Charter of the City and County of Denver.

In accordance with the terms of the Contract Documents, you are required to execute the formal Contract and furnish the required Performance Bond, Payment Bond and insurance certificates within ten (10) consecutive calendar days from and including the date of this receipt of the contract. In addition, you are required to submit the EEO information described in IB-28 before a Notice to Proceed may be issued.

The bid security submitted with your Bid will be returned upon execution of the Contract, the City's receipt of the required Performance and Payment Bonds and insurance certificates, and, if required, City Council approval of the contract. If you should fail to execute the Contract and furnish the Performance and Payment Bonds and insurance certificate within the time limit specified, said bid security will be retained by the City and County of Denver as liquidated damages, and not as a penalty, for the delay and extra work caused thereby.

All construction contracts made and entered into by the City and County of Denver are subject to applicable City and/or Federal Affirmative Action and Equal Employment Opportunity Rules and Regulations, and each contract requiring payment by the City of Five Million Dollars ($5,000,000.00) or more shall first be approved by the City Council acting by Ordinance and in accordance with Section 3.2.6 of the Charter of the City and County of Denver.

Prior to issuance of Notice to Proceed, all Affirmative Action and Equal Employment Opportunity requirements must be completed.

CITY AND COUNTY OF DENVER

By_____
Senior Vice President,
Airport Infrastructure Management

By_____
Chief Executive Officer
Denver International Airport

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CONTRACT

The contract is contained in the pages immediately following this page

These pages are not included in the page numbering of this contract document.

Notice to Bidders

City Required Contract Provisions

The following contract provisions are required in every contract issued by the Department of Aviation. The language of each clause is drafted in accordance with city, state and federal obligations placed on the airport and is not subject to modification. Accordingly, proposers should carefully review this Sample Agreement provided with the Request for Proposals, including these required provisions, in preparation of their proposals.

1. ***Indemnification***
2. ***Basic insurance requirements***
3. ***Limitation of liability (available in narrowly applicable circumstances)***
4. ***Federal requirements***
    a. ***Standard Federal Aviation Administration grant assurances (Appendix 1 to the Sample Agreement)***
    b. ***Federal Aviation Administration document retention and review requirements***
5. ***Airport security requirements***
6. ***City code and charter; state statutes***
    a. ***Prompt pay***
    b. ***Prevailing wage***
    c. ***Immigration provisions (Not applicable for contracts for Information Technology services or IT products and services – See, C.R.S. 8-17.5-101(6)(b)(V))***
    d. ***Colorado open records act***
    e. ***DSBO (if applicable to subject matter of contract)***
    f. ***City nondiscrimination language***
    g. ***Dispute resolution***
7. ***Denver Executive Orders ("XOs")***
    a. ***Environmental***
    b. ***Drugs alcohol tobacco***
    c. ***Nondiscrimination in contracts***
8. ***Airport System General Bond Ordinance (1984, as amended).***
9. ***Choice of law (Colorado)***
10. ***Jurisdiction and venue (Colorado)***

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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 **VENDOR NAME**, a Jurisdiction from the SOS website corporation and authorized to do business in the State of Colorado ("Choose an item."") (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 task orders issued under Contract No. 201951778, Concourse A and C Pre-Conditioned Air Re-Life 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 proposers; 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 subject to the terms of this Contracts, the Parties agree as follows:

ARTICLE I. 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
- Request for Proposals
- Notice to Proceed
- Form of Final Receipt
- Building Information Modeling ("**BIM**") if applicable
- Change Directives
- Change Orders
- Exhibit A Federal Appendices
- Exhibit B Equal Employment Opportunity Provisions
- Exhibit C Insurance Requirements
- Exhibit D Prevailing Wage Schedules
- Exhibit E Special Conditions

SAMPLE

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- 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 Article I through XXXI 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. Exhibit K Invitation for Bids and Contractor's Response to Invitation for Bids
4. Change Directives
5. Change Orders
6. Exhibit B Equal Employment Opportunity Provisions
7. Exhibit E Special Conditions
8. Exhibit F Standard Specifications for Construction General Contract Conditions (2011 Edition) (the "**Yellow Book**") ("**General Conditions**") (Table of Contents attached as Exhibit F)
9. Exhibit C Insurance Requirements
10. Exhibit D Prevailing Wage Schedules
11. Exhibit I Technical Specifications
12. Exhibit J Contract Drawings
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.

ARTICLE II. 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**").

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ARTICLE III. TERM OF CONTRACT

The Senior Vice President of Aviation – Airport Infrastructure Management (the "**SVP-AIM**") will issue a written notice to proceed to Contractor (the "**Notice to Proceed**"), and Contractor shall begin performing the Work required under this Contract within ten (10) days of such Notice to Proceed (the "**Commencement Date**"). Contractor shall fully complete the Work in its entirety within 730 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.

ARTICLE IV. TERMS OF PAYMENT

The City agrees to pay Contractor for the performance and completion of all of the Work as required by the Scope of Work and the Contract Documents, and Contractor agrees to accept as its full and only compensation therefor, a total amount of **Contract Amount Dollars and Amount Cents** (**$Click here to enter text..00**) (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.

ARTICLE V. VERIFIED STATEMENT OF CLAIMS

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

ARTICLE VI. DISPUTES

All disputes arising under or related to this Contract shall be resolved by administrative hearing under the procedures described in Denver Revised Municipal Code Section 5-17 ("**D.R.M.C.**") and all related rules and procedures. 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.

ARTICLE VII. DEFENSE AND INDEMNIFICATION

A. To the fullest extent permitted by law, the 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,

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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 Article V. 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.

ARTICLE VIII. 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.

ARTICLE IX. 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 as further set forth in the Special Conditions shall be:

Milestone	Date of Completion	Amount Per Day
Concourse A Pre-Conditioned C Air Chillers	300 calendar days from Notice to Proceed	$3,500 per day
Concourse C Pre-Conditioned Air Chillers	365 calendar days from Notice to Proceed	$3,500 per day
Concourse A Heat Exchangers	730 calendar days from Notice to Proceed	$1,000 per day

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Concourse C Heat Exchangers	548 Calendar Days from Notice to Proceed	$1,000 per day

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 Contractor. Additional provisions relating to liquidated damages are set forth in the Construction Contract General Conditions and Special Conditions.

ARTICLE X. 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 Contract, including any extensions of the Contract or other extended period stipulations stated in ***Exhibit C***. All certificates of insurance and any required endorsements must be received and approved by DEN Risk Management before any airport access or work commences.

B. Unless specifically excepted in writing by DEN Risk Management, if Contractor shall be using subcontractors to provide any part of the services under this Contract, Contractor shall do one of the following:

1. Include all subcontractors performing services hereunder as insureds under its required insurance and specifically list on all submitted certificates of insurance required under ***Exhibit C***; or

2. Ensure that each subcontractor provides its own insurance coverage in accordance with the requirements set forth in this Contract.

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.

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ARTICLE XI. 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.

ARTICLE XII. 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.

ARTICLE XIII. 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 his/her 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 his/her authorized representative, automatically terminate this Contract and all rights of Contractor hereunder.

ARTICLE XIV. 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 and otherwise lawfully made available for the purposes of this Contract from the City and County of Denver Municipal 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.

ARTICLE XV. 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.

ARTICLE XVI. 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.

ARTICLE XVII. NO DISCRIMINATION IN EMPLOYMENT

In connection with the performance of work under this Contract, Contractor agrees not to refuse to hire, discharge, promote or demote, or to discriminate in matters of compensation against any person otherwise qualified, solely because of race, color, religion, national origin, gender, age,

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military status, sexual orientation, gender variance, marital status, or physical or mental disability; and Contractor further agrees to insert the foregoing provision in all subcontracts hereunder.

ARTICLE XVIII. 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.

ARTICLE XIX. COMPLIANCE WITH ALL LAWS AND REGULATIONS

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 Charter, ordinances and rules and regulations of the City.

ARTICLE XX. PROMPT PAYMENT

A. Contractor is subject to D.R.M.C. § 20-112, which requires the Contractor is to pay its subcontractors in a timely fashion. Contractor's payment is timely if it is mailed to the subcontractor no later than seven (7) days after receipt of payment for the work from City. Any late payments are subject to a late payment penalty as provided for in the prompt payment ordinance (D.R.M.C. §§ 20-107 through 20-118).

B. In accordance with D.R.M.C. § 20-109(e) and General Condition 909.1(H), Contractor agrees to waive prompt payment interest for any invoices which are not timely submitted and accepted by the City in their final, complete and responsive form. All invoices which are not submitted in their complete and responsive form within sixty (60) days of the completion of the Work shall be deemed untimely.

ARTICLE XXI. 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 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 three (3) years after termination of this Contract. Upon written request from the City, Contractor shall deliver any information requested pursuant to this Article within ten (10) business days in the event a schedule or otherwise agreed-upon timeframe does not exist.

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ARTICLE XXII. 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 Article V.

ARTICLE XXIII. EXAMINATION OF RECORDS AND AUDITS

A. Any authorized agent of the City, including the City Auditor or his or her representative, has the right to access, and the right to examine, copy and retain copies, at City's election in paper or electronic form, any pertinent books, documents, papers and records related to Contractor's performance pursuant to this Contract, provision of any goods or services to the City, and any other transactions related to this Contract. Contractor shall cooperate with City representatives and City representatives shall be granted access to the foregoing documents and information during reasonable business hours and until the latter of three (3) years after the final payment under the Contract or expiration of the applicable statute of limitations. When conducting an audit of this Contract, the City Auditor shall be subject to government auditing standards issued by the United States Government Accountability Office by the Comptroller General of the United States, including with respect to disclosure of information acquired during the course of an audit. No examination of records and audits pursuant to this paragraph shall require Contractor to make disclosures in violation of state or federal privacy laws. Contractor shall at all times comply with D.R.M.C. § 20-276.

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B. Additionally, Contractor agrees until the expiration of three (3) years after the final payment under this Contract, any duly authorized representative of the City, including the CEO or his or her 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 Consultant'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.

ARTICLE XXIV. 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 Click here to enter text..

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

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

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

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

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

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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.

ARTICLE XXV. MINIMUM WAGE REQUIREMENTS

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

ARTICLE XXVI. COMPLIANCE WITH MINORITY/WOMEN BUSINESS ENTERPRISE REQUIREMENTS

This Contract is subject to all applicable provisions of D.R.M.C. Chapter 28 ("**M/WBE Ordinance**"). In accordance with the requirements of the M/WBE Ordinance, Contractor is committed to, at a minimum, meet the participation goal of Fifteen percent (15%), established for this Project utilizing properly certified M/WBE subcontractors and suppliers. Without limiting the general applicability of the foregoing, Contractor acknowledges its continuing duty, pursuant to D.R.M.C. §§ 28-72, 28-73 and 28-75 and the M/WBE Program, to meet and maintain throughout the duration of this Contract its participation and compliance commitments and to ensure that all Subcontractors subject to the M/WBE Ordinance or the M/WBE Program also maintain such commitments and compliance. Failure to comply with these requirements may result, at the discretion of the Director of the Division of Small Business Opportunity ("**DSBO**"), in the imposition of sanctions against Contractor in accordance with D.R.M.C. § 28-77. Nothing contained in this Article or in the M/WBE Ordinance shall negate the City's right to prior approval of Subcontractors, or substitutes therefore, under this Contract.

ARTICLE XXVII. 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 the DEN's Security Office.

ARTICLE XXVIII. 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

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

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

ARTICLE XXIX. 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 Denver Municipal Airport System.

1. 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 subtier contractors 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.

2. 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.

3. 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

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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.

4. 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 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 City to enter into any litigation to protect the interests of City. In addition, Contractor may request the United States to enter into the litigation to protect the interests of the United States.

ARTICLE XXX. 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.

ARTICLE XXXI. 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.

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Appendix No. 1

Standard Federal Assurances and Nondiscrimination Non-Federal Construction Provision

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APPENDIX 1-A

GENERAL CIVIL RIGHTS PROVISIONS

The 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 the contractor and subtier contractors 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.

COMPLIANCE WITH NONDISCIRIMINATION REQUIREMENTS

The term "sponsor" shall mean the "City."

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

1. **Compliance with Regulations**. The Contractor will comply with the Title VI List of Pertinent Non-Discrimination Statutes and Authorities, as they may be amended from time to time, which are herein incorporated by reference and made part of this Agreement.

2. **Nondiscrimination**. The Contractor, with regard to the work performed by it during this Agreement, will not discriminate on the grounds of race, creed, color, national origin, or sex 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 Acts and Regulations, including employment practices when the Agreement covers any activity, project, or program set forth in Appendix B of 49 CFR Part 21.

3. **Solicitations for Subcontractors, 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 Agreement and the Acts and Regulations relative to nondiscrimination 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, Regulations or 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 (FAA) to be pertinent to ascertain compliance with such Acts, Regulations, and instructions. Where any information required of a Contractor is in the exclusive possession of another who fails or refuses to furnish this information, the Contractor shall so certify to the sponsor or the FAA, as appropriate, and

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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 nondiscrimination provisions of this Agreement, the sponsor will impose such Contract sanctions as it or the FAA may determine to be appropriate, including, but not limited to:

a. Withholding of payments to the Contractor under this Agreement until the Contractor complies, and/or;

b. Cancelling, terminating, or suspending this Agreement, in whole or in part.

6. **Incorporation of Provisions**. The Contractor will include the provisions of paragraphs one (1) through six (6) in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Acts, the Regulations or directives issued pursuant thereto. The Contractor will take action with respect to any subcontract or procurement as the sponsor or the FAA 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 such litigation to protect the interests of the sponsor. In addition, the Contractor may request the United States to enter into such litigation to protect the interests of the United States.

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APPENDIX 1-C

CLAUSES FOR TRANSFER OF REAL PROPERTY ACQUIRED OR IMPROVED UNDER THE ACTIVITY, FACILITY, OR PROGRAM

As used below, the term “sponsor” will mean City.

Contractor, for himself/herself, his/her heirs, personal representatives, successors in interest, and assigns, as part of consideration hereof, does hereby covenant and agree, as a covenant running with the land that:

1. In the event facilities are constructed, maintained, or otherwise operated on the property described in this Agreement for a purpose for which a FAA activity, facility, or program is extended or for another purpose involving the provision of similar services or benefits, the Contractor will maintain and operate such facilities and services in compliance with all requirements imposed by the Nondiscrimination Acts and Regulations listed in the Pertinent List of Nondiscrimination Authorities, as may be amended from time to time, such that no person on the grounds of race, color, or national origin, will be excluded from participation in, denied the benefits of, or be otherwise subjected to discrimination in the use of said facilities.

2. With respect to this Agreement, in the event of breach of any of the above Nondiscrimination covenants, sponsor will have the right to terminate this Agreement, and to enter, re-enter, and repossess said lands and facilities thereon, and hold the same as if this Agreement had never been made or issued.

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APPENDIX 1-D

STANDARD FEDERAL ASSURANCES AND NONDISCRIMINATION IN CONSTRUCTION, USE, OR ACCESS TO FACILITES

As used below, the term “sponsor” will mean City.

A. Contractor for himself/herself, his/her heirs, personal representatives, successors in interest, and assigns, as part of the consideration hereof, does hereby covenant and agree, as a covenant running with the land, that (1) no person on the ground of race, color, or national origin, will be excluded from participation in, denied the benefits of, or be otherwise subjected to discrimination in the use of said facilities, (2) that in the construction of any improvements on, over, or under such land, and the furnishing of services thereon, no person on the ground of race, color, or national origin, will be excluded from participation in, denied the benefits of, or otherwise be subjected to discrimination, (3) that the Contractor will use the Premises in compliance with all other requirements imposed by or pursuant to the List of Pertinent Nondiscrimination Authorities.

B. With respect this Agreement, in the event of breach of any of the above nondiscrimination covenants, sponsor will have the right to terminate this Agreement and to enter, re-enter, and repossess said land and the facilities thereon, and hold the same as if this Agreement had never been made or issued.

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APPENDIX 1-E

TITLE VI LIST OF PERTINENT NONDISCRIMINATION AUTHORITIES

The term "sponsor" will mean City.

During the performance of this Agreement, the Contractor, for itself, its assignees, and successors in interest (hereinafter referred to as the "Contractor") agrees to comply with the following nondiscrimination statutes and authorities; including but not limited to:

- Title VI of the Civil Rights Act of 1964 (42 U.S.C. § 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 U.S.C. § 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 U.S. C. § 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 U.S.C. § 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 1 00-209), (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 Ill 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 U.S.C. §§ 12131 -12189) as implemented by Department of Transportation regulations at 49 CFR parts 37 and 38;
- The Federal Aviation Administration's Non-discrimination statute (49 U.S.C. § 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 discrimination against minority populations by discouraging programs, policies, and activities with disproportionately high

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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 U.S. C. 1681 et seq).

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APPENDIX 1-F

FEDERAL FAIR LABOR STANDARDS ACT (FEDERAL MINIMUM WAGE)

All contracts and subcontracts that result from this solicitation incorporate by reference the provisions of 29 CFR part 201, the Federal Fair Labor Standards Act (FLSA), with the same force and effect as if given in full text. The FLSA sets minimum wage, overtime pay, recordkeeping, and child labor standards for full and part time workers.

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

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APPENDIX 1-G

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. The 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.

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PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned _____ _____ [Bidder name], a corporation organized under the laws of the State of _____ [Bidder state], hereinafter referred to as the "Contractor" and _____ _____ [Bond issuer], a corporation organized under the laws of the State of _____ [Bond company state], 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 _____ [Bid amount text] Dollars ($_____), 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 201951778, Concourse A & C Pre-Conditioned Air Re-Life, 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)

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IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this _____ day of _____, _____.

_____
CONTRACTOR

By:_____
President

_____
SURETY

By:_____
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:

KRISTIN M. BRONSON, Attorney for the City and County of Denver

By:_____
Assistant City Attorney

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PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned _____ _____ [Bidder name], a corporation organized under the laws of the State of _____ [Bidder state], hereinafter referred to as the "Contractor" and _____ _____ [Bond issuer], a corporation organized under the laws of the State of _____ [Bond company state], 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 _____ [Bid amount text] Dollars ($_____), 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 201951778, Concourse A & C Pre-Conditioned Air Re-Life, 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]

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IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this _____ day of _____, _____.

_____
CONTRACTOR

By:_____
President

_____
SURETY

By:_____
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:

KRISTIN M. BRONSON, Attorney for the City and County of Denver

By:_____
Assistant City Attorney

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CITY AND COUNTY OF DENVER

DEPARTMENT OF AVIATION

* * * * * * * * * * * * * *

NOTICE TO PROCEED

Date:

TO: [Bidder name and address]

You are hereby authorized and directed to proceed on this date with the work of constructing Contract No. 201951778, Concourse A & C Pre-Conditioned Air Re-Life, Denver International Airport, Denver, Colorado, as set forth in detail in the Contract Documents for the City and County of Denver.

The bid security submitted with your bid is herewith returned to you.

CITY AND COUNTY OF DENVER

By_____
Senior Vice President
Airport Infrastructure Management

By_____
Chief Executive Officer
Denver International Airport

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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

Statement
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SPECIAL CONDITIONS

SC-1 CONSTRUCTION CONTRACT GENERAL CONDITIONS

The General Conditions constitute a part of the Contract Documents and 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 (which may be informally referred to as the "Yellow Book"). The General Conditions book is available for purchase at the following locations during the business hours stated, Monday through Friday, excluding holidays:

Office of the Cashier
Wellington E. Webb Municipal Office Building, 2nd Floor
201 West Colfax Avenue
Denver, Colorado, USA 80202
7:30 a.m. to 4:30 p.m.
The General Conditions are also available on the DEN Contract Procurement website and the City and County of Denver website at:

https://www.denvergov.org/content/denvergov/en/contract-administration/contractor-resources/general-contract-conditions.html
http://business.flydenver.com/bizops/commerceHub.asp

SC–2 DRAWINGS AND SPECIFICATIONS TO BE FURNISHED BY THE CITY

The City will provide the following contract documents to the Contractor in electronic format at no expense to the Contractor:

Construction Safety and Phasing Plan (CSPP) IFB
IFB Division 1 Specifications - General Requirements
IFB Division 2 Technical Specifications
Contract Drawings - Concourse A & C Pre-Conditioned Air Re-Life

Paper copies of the Contract 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.

SC-3 REVISIONS TO G.C. 201

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

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SC-4 CITY LINE OF AUTHORITY AND CONTACTS

In accordance with General Condition 214, the City's line of authority for administration of this Contract is:

Chief Executive Officer (CEO). Executive Office, 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 Operating Officer (EVP-COO) who reports to the CEO. Airport Infrastructure Management office, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

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

Senior Director of Airport Infrastructure Management (Director), reports to the SVP-AIM, Airport Infrastructure Management Division, Airport Office Building, 8500 Peña Boulevard, Denver, CO 80249.

Project Manager, the City representative who has day to day administrative responsibility of this Contract, and who reports to the Senior Director-AIM. All notices, requests, pay applications (pursuant to G.C. 902), and other correspondence from the Contractor shall be sent to the assigned Project Manager unless otherwise provided in this Contract.

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

SC–5 CONTRACTOR PERFORMANCE; SUBCONTRACTING

With respect to General Condition 501, no more than 80% of the work may be subcontracted. If it is determined to be in the City's best interest, this percentage may be modified throughout the course of the project by the SVP-AIM.

SC–6 COOPERATION WITH OTHERS

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

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

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Contract No.	Description
201733063	Concourse Expansion
201631723	Concourse Expansion
201951349	Boiler 1, 3, 4
TBD	Pump Room Replacement
TBD	CUP Chiller Replacement
TBD	Passenger Loading Bridge
TBD	New Pre Conditioned Air Units at the Passenger Loading Bridges (installation)

SC–7 PROSECUTION AND COMPLETION OF THE WORK:

The Work to be performed under the Contract is described in the Technical Specifications and Contract Drawings. The Contractor shall complete the Work within five hundred forty-eight (548) consecutive calendar days from Notice to Proceed.

The Work to be performed under the Contract is divided into the following 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 below:

Milestone	Date of Completion (or, days from NTP)
1. CCA PC Air Chillers substantial completion	300 calendar days from Notice to Proceed
2. CCC PC Air Chillers substantial completion	365 calendar days from Notice to Proceed
3. CCA Heat Exchangers substantial completion	548 calendar days from Notice to Proceed
4. CCC Heat Exchangers substantial completion	548 calendar days from Notice to Proceed

SC–8 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 per phase (Items 1-4) until each partial substantial completion is achieved. Additionally, if the Contractor fails to substantially complete the Work described in a project Milestone within the time specified in SC-7 PROSECUTION AND COMPLETION OF THE WORK, the Contractor shall be liable to the City for liquidated damages at the following rates per day until such substantial completion is achieved:

Failure to substantially complete the Work described in Milestone:

	Amount per day
1. CCA PC Air Chillers Sub complete	$3,500.00
2. CCC PC Air Chillers Sub complete	$3,500.00
3. CCA Heat Exchangers sub complete	$1,000.00
4. CCC Heat Exchangers sub complete	$1,000.00

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

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SC–9 FACILITY SECURITY AND PERSONNEL ACCESS

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

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

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

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

The construction of all the Project / Task Items that involve the breaching of any airport perimeter security boundary or continued access to restricted access rooms or areas will require the posting of authorized contract security personnel to maintain required security controls. The Contractor's **Guarantee Maximum Price / Total Contract BID Amount / Task Order Proposal** 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

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RESULT IF AIRPORT PERIMETER SECURITY REQUIREMENTS ARE NOT STRICTLY FOLLOWED. THE REQUIREMENT TO PROVIDE ONE HUNDRED PERCENT (100%) CONTROL AND SUPERVISION OF BREACHES IN THE AIRPORT'S PERIMETER SECURITY BOUNDARY IS ABSOLUTE. AT NO TIME, DURING WORK AND NON-WORK HOURS SHALL ANY BREACHES IN THE AIRPORT'S SECURITY PERIMETER BE UNSUPERVISED AND / OR UNSECURED.

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

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

HSS
900 S. Broadway, Suite 100
Denver, Colorado 80209

DEN Contact: Glenn Spies
(303) 342-4323

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

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

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

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

SC-10 CONSTRUCTION ACCESS

The work site(s) is(are) located at Concourse A and Concourse C tunnels. The Contractor shall have access to the work site via Gate 5 and Concourse Apron Entrances.

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.

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

SC–11 VEHICLE PERMITTING

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

SC–12 VENDORS AND SUPPLIERS

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

SC–13 COMMUNICATION DEVICES

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

SC–14 USE, POSSESSION OR SALE OF ALCOHOL OR DRUGS

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

SC-15 ATTORNEY'S FEES

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

SC–16 INSURANCE REQUIREMENTS

In accordance with the provisions of Title 16 of the General Conditions, the minimum insurance requirements for this contract are set forth in the ROCIP III Insurance Manual, linked under the insurance requirements for this Contract. 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

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

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

The City and County of Denver in no way warrants that the minimum limits contained herein are sufficient to protect the Contractor from liabilities that might arise out of the performance of the work under this Contract by the Contractor, his agents, representatives, employees or sub- contractors. The Contractor shall assess its own risks as it deems appropriate and/or prudent, maintain higher limits and/or broader coverages. The Contractor is not relieved of any liability or other obligations assumed or pursuant to the Contract by reason of its failure to obtain or maintain insurance in sufficient amounts, duration or types.

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

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

All certificates required by this Contract shall be sent directly to Denver International Airport, Business Management Services, Airport Office Building, Room 8810, 8500 Pena Boulevard, Denver, Colorado 80249. The City project/Contract number and project description shall be noted on the certificate of insurance. The City reserves the right to require complete, certified copies of all insurance policies required by this Contract at any time.

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

SC–17 SUBCONTRACTOR RELEASES

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

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SC–18 ADDITIONAL AFFIRMATIVE ACTION REQUIREMENTS, FEDERAL PROVISIONS

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

SC-19 ESTIMATED QUANTITIES OF UNIT PRICED ITEMS

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

SC-20 REVISIONS TO G.C. 1102

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

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

SC-21 LISTING OF ACCEPTABLE MANUFACTURERS

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

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

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

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

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

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

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

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

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

SC-24 PAYMENTS TO CONTRACTORS

The Contractor recognizes and agrees that applications for payment shall be submitted using the Textura® Construction Payment Management System (CPM 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 CPM 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 CPM 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 CPM 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:

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Agency/Firm
DEN Division CA
DEN Division PM
DEN Division Director
DEN Contract Svcs 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 completed Partial or Final Claim Release Form, as appropriate, from EACH subcontractor and supplier, **AND** the Contractor's Certification of Payment Form.

SC-25 DISPOSAL OF NON-HAZARDOUS WASTE AT DADS

In accordance with the Landfill Contract made between the City and Waste Management of Colorado, Inc., bidders will be required to haul dedicated loads (non-hazardous entire loads of waste) to the Denver-Arapahoe Disposal Site ("**DADS**") for disposal. DADS is located at Highway 30 and Hampden Avenue in Arapahoe County, Colorado. The City will pay all fees associated with such disposal but the bidder shall be responsible for the costs of transporting the loads. Non-hazardous waste is defined as those substances and materials not defined or classified as hazardous by the Colorado Hazardous Waste Commission pursuant to C.R.S. § 25-15-207, as amended from time to time, and includes construction debris, soil and asbestos. Bidders shall not use Gun Club Road between I-70 and Mississippi Avenue as a means of access to DADS.

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DENVER INTERNATIONAL AIRPORT
PARTIAL LIEN RELEASE – CONSTRUCTION
(Subcontractor)

Project: _____ Date: _____

City Contract No. _____ Current Subcontract Amount: $_____

FROM:
Subcontractor _____

(1) Last Progress Payment for billing period ending _____ 20____
$_____

Address: _____

City/State: _____

(2) Progress invoiced for previous billing period (if unpaid) _____ 20____
$_____

Telephone: _____

TO:
Contractor _____

(3) Progress invoiced for current billing period ending _____ 20____
$_____

Address: _____

City/State: _____

(4) **Total Paid to Date:**
$_____

( ) MBE/WBE ( ) SBE ( ) DBE ( ) Non

The Undersigned hereby certifies that all costs, charges or expenses incurred by the undersigned or on behalf of the undersigned for any work, labor or services performed and for any materials, supplies or equipment provided on the above referenced Project or used in connection with the above referenced Subcontract (the "Work Effort") have been duly paid in full to date.

The Undersigned further certifies that each of the undersigned's subcontractors and suppliers that incurred or caused to be incurred, on their behalf, costs, charges or expenses in connection with the undersigned's Work Effort on the above referenced Project have been duly paid in full to date.

The Undersigned hereby (1) acknowledges receipt of the progress payment referred to above as the Last Progress Payment which, when added to the total of all previous progress payments, constitutes full payment, less retainage, for all labor, services, material and supplies which the undersigned has provided for use in and upon the project described above through _____, 20____ and, (2) hereby releases the Contractor, surety, the City and County of Denver, and any intermediate subcontractor or supplier of any tier from any and all claims prior to the above mentioned date, except for the withheld retainage.

The Undersigned also hereby agrees that the Contractor, Surety, the City and County of Denver, and any intermediate subcontractor or supplier of any tier shall be released from any and all claims arising out of its performance or non-performance of any contract associated with the above project through _____, 20

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_____, except for withheld retainage after it has received full payment, less retainage, of the amount invoiced for the current billing period.

As additional consideration for the payments referenced above, the undersigned agrees to defend, indemnify and hold harmless the City, its officers, employees, agents and assigns and the above-referenced Contractor from and against all costs, losses, damages, causes of action, judgments under the subcontract and expenses arising out of or in connection with any claim or claims against the City or the Contractor which arise out of the Undersigned's performance of the Work Effort and which may be asserted by the Undersigned or any of its suppliers or subcontractors of any tier or any of their representatives, officers, agents, or employees.

It is acknowledged that this release is for the benefit of and may be relied upon by the City and the referenced Contractor.

The foregoing shall not relieve the undersigned of any obligation under the provisions of the Undersigned's subcontract, as the subcontract may have been amended, which by their nature survive completion of the Undersigned's work effort including, without limitation, warranties, guarantees, insurance requirements and indemnities.

Subcontractor: _____

Certified by: _____

Title: _____

Date: _____

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DENVER INTERNATIONAL AIRPORT
FINAL LIEN RELEASE – CONSTRUCTION
(Subcontractor)

Project: _____ Date: _____

City Contract No. _____ Subcontractor Contract No. _____

Dated: _____, 20 ___

FROM:
Subcontractor: _____ (1) Last Progress Payment for billing period ending _____, 20 ___

Address: _____ $_____

City/State: _____ (2) Does not apply

Telephone: _____

TO:
Contractor: _____ (3) Does not apply

Address: _____

City/State: _____ (4) **Total Paid to Date:**

$_____

( ) SBE ( ) DBE ( ) MBE ( ) WBE ( ) Non

The Undersigned hereby certifies that all costs, charges or expenses incurred by the undersigned or on behalf of the undersigned for any work, labor or services performed and for any materials, supplies or equipment provided on the above referenced Project or used in connection with the above referenced Subcontract (the "Work Effort") have been duly paid in full.

The Undersigned further certifies that each of the undersigned's subcontractors and suppliers that incurred or caused to be incurred, on their behalf, costs, charges or expenses in connection with the undersigned's Work Effort on the above referenced Project have been duly paid in full.

The undersigned Subcontractor hereby (1) acknowledges receipt of the progress payment referred to above as the Last Progress Payment which, when added to the total of all previous progress payments, constitutes full payment for all labor, services, materials and supplies which the undersigned has provided for use in and upon the project described above through _____, 20____ and, (2) hereby releases the Contractor, Surety, the City and County of Denver, and any intermediate subcontractor or supplier of any tier from any and all claims prior to the above mentioned date.

The Subcontractor also hereby agrees that the Contractor, Surety, the City and County of Denver, and any intermediate subcontractor or supplier of any tier shall be released from any and all claims arising out of its performance or non-performance of any contract associated with the above project.

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As additional consideration for the payments referenced above, the undersigned agrees to defend, indemnify and hold harmless the City, its officers, employees, agents and assigns and the above-referenced Contractor from and against all costs, losses, damages, causes of action, judgments under the subcontract and expenses arising out of or in connection with any claim or claims against the City or the Contractor which arise out of the Undersigned's performance of the Work Effort and which may be asserted by the Undersigned or any of its suppliers or subcontractors of any tier or any of their representatives, officers, agents, or employees.

It is acknowledged that this release is for the benefit of and may be relied upon by the City and the referenced Contractor.

The foregoing shall not relieve the undersigned of any obligation under the provisions of the Undersigned's subcontract, as the subcontract may have been amended, which by their nature survive completion of the Undersigned's work effort including, without limitation, warranties, guarantees, insurance requirements and indemnities.

Subcontractor: _____

Certified by: _____

Title: _____

Date: _____

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

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

APPROVED FOR LEGALITY:

/s/_____
Attorney for the City and
County of Denver

APPROVED AND ADOPTED:

/s/_____
Manager of Public Works

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

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

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RULES AND REGULATIONS
REGARDING
EQUAL EMPLOYMENT OPPORTUNITY

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

RULE I
DEFINITIONS

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

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RULE II
NOTICE OF HEARING

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

RULE III
HEARING

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

REGULATIONS

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

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

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

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

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

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

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

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

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

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

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

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

All amendments to the appendices shall be included by reference.

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

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

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

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

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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 f6r training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
2. The contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap.
3. The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided, advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
4. Each contractor will comply with all provisions of Article III, Division 2, Chapter 28 of the Revised Municipal Code, and the rules, regulations, and relevant orders of the Manager and Director.
5. The contractor will furnish all information and reports required by Article III, Division 2, Chapter 28 of the Revised Municipal Code, and by rules, regulations and orders of the Manager and Director or pursuant thereto, and will permit access to his books, records, and accounts by the Manager, Director or their designee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
6. In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations or orders this contract may be cancelled, terminated., or suspended in whole or in part and the contractor may be declared ineligible for further City contracts in accordance with procedures authorized in Article III, Division 2, Chapter 28 of the Revised Municipal Code, or by rules, regulations, or order of the Manager.
7. The contractor will include Regulation 12 Paragraph 2 and the provisions of paragraphs (1) through (6) in every subcontract or purchase order unless, exempted by rules, regulations, or orders of the Manager issued pursuant to Article III, Division 2, Chapter 28 of the Revised Municipal Code, so that such provisions will be binding upon each subcontractor or suppliers. The contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance.

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

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

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

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

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APPENDIX F
BID CONDITIONS
AFFIRMATIVE ACTION REQUIREMENTS
EQUAL EMPLOYMENT OPPORTUNITY

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

NOTICE

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

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

EULOIS CLECKLEY
Manager of Public Works
City and County of Denver

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A. REQUIREMENTS --AN AFFIRM ATIVE ACTION PLAN:

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

1. GOALS AND TIMETABLES:

The goals and timetables for minority[1] 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 21.7% - 23.5% Until Further Notice	From January 1, 1982 to 6.9% Until Further Notice

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

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

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

[1] "Minority" is defined as including, Blacks, Spanish Surname Americans, Asian-Americans, and American Indians, and includes both men and Minority women.

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2. **SPECIFIC AFFIRMATIVE ACTION STEPS**:

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

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

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

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

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

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

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

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

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

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

B. **Obligations Applicable to Contractors**:

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

C. **General Requirements**

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

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

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March 19, 2020

Concourse A and C Pre-Conditioned Air Re-Life

CONTRACT NO. 201951778

ADDENDUM NUMBER ONE

This Addendum Number One supersedes and/or supplements all portions of the Invitation for Bid documents with which it conflicts. ***Proposers must acknowledge receipt of this addendum on Page 28 of the Bid Forms***.

Tony Deconinck

Tony Deconinck
Contract Administrator

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DENVER INTERNATIONAL AIRPORT

CONCOURSE A AND C PRE-CONDITIONED AIR RE-LIFE
CONTRACT NO. 201951778

ADDENDUM NUMBER ONE

Scope of this Addendum

Addendum Number One includes modifications to the following Invitation for Bid documents issued February 21, 2020. These modifications are deemed necessary by the City and County of Denver.

NOTICE OF INVITATION FOR BIDS

The second paragraph on bid submittal and bid opening shall be deleted in its entirety and replaced with the following:

Bids for this project will not be received in person. There are two ways to submit bids:

1. Bids can be converted to Adobe PDF format and submitted via email to contract.procurement@flydenver.com. The email subject line must read, "Bid Submittal: Concourse A & C Pre-Conditioned Air Re-Life – 201951778". For electronic submittals, the original bid bond must be received by mail (see address below) within 7 calendar days of bid opening date to be considered part of a responsive bid.
2. Bids can be mailed to Denver International Airport, 8500 Peña Blvd., Denver, CO 80249-6340, Attention: Tony Deconinck. Mail-in bids must indicate the project name and project number on the outside of the box or envelope.

Bids received after the due date and time will be rejected as non-responsive. Incomplete bids will be deemed non-responsive. Bids received by the due date and time will be opened by the Contract Administrator and the bidders' names and bid amounts will be posted online; however, no rankings will be applied until DEN has confirmed that the bids received are responsive.

The total number of pages (including cover sheet) contained in this Addendum Number One is two (2).

* * * * * * *

End of Addendum Number One

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DENVER INTERNATIONAL AIRPORT
BID FORMS

CONTRACT NAME: Concourse A & C Pre-Conditioned Air Re-Life
Contract No.: 201951778

Bid Letter

BIDDER PCL Construction Services, Inc.

Chief Executive Officer
City and County of Denver
Business Management Services (Procurement) Office
Airport Office Building, Room 8810
Denver International Airport
8500 Peña Boulevard
Denver, Colorado 80249

This letter is in response to the Notice of Invitation for Bids first published on February 21, 2020, for Contract No. 201951778, Denver International Airport, Concourse A & C Pre-Conditioned Air Re-Life.

This contract is for full replacement of mechanical equipment on Concourses A and C that supply the PC Air units on Concourses A and C. This scope also includes the replacement of floor slabs in each plant with structural, void form floors and micro piles to mitigate floor heaving that currently plagues the existing plants. In addition to these improvements, walls will be relocated in the concourse A plant in order to provide additional space for future ice storage that the new system is designed to connect into if DEN so chooses. The project will be phased to coordinate with the opening of the concourse expansions on Concourses A and C.

The undersigned Bidder declares that it has carefully examined the location of the proposed work and has carefully read and examined all of the contract documents which include, but are not limited to, the Contract Drawings, Technical Specifications, Construction Contract General Conditions, Special Conditions, Instruction to Bidders, and EEO provisions, and hereby proposes to furnish all labor, materials, equipment, tools, transportation and services, and to discharge all duties and obligations necessary and required to perform and complete the Work as required in the contract documents which are provided herewith and by this reference made a part hereof for the prices shown in the bid forms and totaled below:

TOTAL BID Amount: Seventeen Million One Hundred Thousand Dollars and zero Cents ($17,100,000).

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The undersigned acknowledges receipt, understanding and full consideration of the following addenda to the contract documents:

Addenda Nos.: 1- 4

The undersigned agrees that this bid is a firm offer to the City to perform and complete the Contract described above which cannot be withdrawn for one hundred twenty (120) calendar days after the bids are opened or until after a contract for the work described in these bid documents is fully executed by the City, whichever date is earlier.

The undersigned Bidder hereby agrees to appear at Denver International Airport, Business Management Services Office, Room 8810, Airport Office Building, at any time within ten (10) calendar days from the date of a written notice from the CEO to do so, mailed, emailed, or faxed to the business address of Bidder and at that time the Bidder shall: (1) deliver an executed Contract which conforms with this bid; (2) furnish the required performance and payment bonds in the sum of the Total Contract Bid Amount shown above, executed by a surety company acceptable to the CEO; and (3) furnish the required insurance documents.

Enclosed herewith is a bid guarantee, as defined in the Instructions to Bidders, in the amount of which bid guarantee the undersigned Bidder agrees is to be paid to and become the property of the City as liquidated damages should the bid be considered to be the best by the City and the undersigned Bidder notified that it is the apparent low bidder and it fails to enter into contract in the form prescribed and to furnish the required performance and payment bonds and evidences of insurance within ten (10) calendar days as stipulated above.

Attached and incorporated herein are the proposed Schedule of Prices and Quantities and Bid Data Forms. All of the forms must be completed. Bidder acknowledges that the City may incorporate, at its option, any or all of the data submitted by the Bidder into a contract arising out of this Bid.

The undersigned Bidder acknowledges the right of the City to waive informalities in the bids, to reject any or all bids submitted, and to re-advertise for bids.

The undersigned certifies that it has examined and is fully familiar with all of the provisions of the contract documents and is satisfied that they are accurate; that it has carefully checked all words and figures and all statements made in these Bid forms; and that it has satisfied itself with respect to the actual site conditions and the nature and location of the Work, the general and local conditions which may be encountered in the performance of the Work, and other matters which in any way affect the Work or the cost thereof.

[CERTIFICATION AND SIGNATURE ON FOLLOWING PAGES]

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This bid is submitted upon the declaration that neither, I (we), nor, to the best of my (our) knowledge, none of the members of my (our) firm or company have either directly or indirectly entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this bid.

Dated this 30th day of April, 2020.

BUSINESS ADDRESS OF BIDDER: 2000 S. Colorado Blvd. Suite 2-500

City, State, Zip Code: Denver, CO 80222

Telephone Number of Bidder: (303) 365-6500

Fax Number of Bidder: (303) 365-6590

Bidder Social Security or Employer ID: 32707

Bidder Email Address: mlpeter@pcl.com

Bidder's Point of Contact Name: Melissa Peter

SIGNATURE OF BIDDER:

PCL CONSTRUCTION SERVICES, INC. - COLORADO - SEAL

PRINT NAME OF BIDDER:

Ryan Schmidt, PCL Construction Services, Inc.

Attest:

(Corporate Seal)

Secretary

By:

~~President~~
District Manager

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DENVER INTERNATIONAL AIRPORT

BID TABULATION: SCHEDULE OF PRICES AND QUANTITIES

Concourse A & C Pre-Conditioned Air Re-Life

SCOPE

ITEM NO.	DESCRIPTION AND PRICE	QUANTITY	UNIT	UNIT PRICE	EXTENDED PRICE
GENERAL REQUIREMENTS					
01 50 50	Mobilization Fifty eight thousand two hundred fifty five dollars and zero cents. ($ 58,255) lump sum.	1	LS	58,255	58,255
01 66 10 TNP	Storage and Protection Fifteen thousand four hundred eighty one dollars and zero cents. ($ 15,481) per lump sum.	1	LS	15,481	15,481
01 31 00	Project Management and Coordination Eight hundred fifty-six thousand nine-hundred eight dollars and zero cents. ($ 856,908) per lump sum.	1	LS	856,908	856,908
IFB	Textura Fee Twenty thousand three-hundred forty five dollars and zero cents. ($ 20,345) per lump sum.	1	LS	20,345	20,345
Division 01, all others	Other General Requirements One Million Three Hundred Sixty Four Thousand Nine dollars and no cents. ($ 1,364,009) per lump sum.	1	LS	1,364,009	1,364,009
	Division Subtotal				$ 2,314,998
EXISTING CONDITIONS					
02 41 19	Selective Demolition Four Hundred forty two thousand six hundred thirty four dollars and zero cents. ($ 442,634) per Lump Sum.	1 - CCA 1 - CCC	LS LS	265 580 177,053	265,580 177,053
	Division Subtotal				$ 442 634
CONCRETE					
03 30 00	Cast-In-Place Concrete One million nine hundred two thousand and twenty nine dollars and zero cents. ($ 1,902,029) per Lump Sum.	1 - CCA 1 - CCC	LS LS	1,141,217 760,812	1,141,217 760,812
	Division Subtotal				$ 1 092 029
METALS					
Division 5	Metals Thirty thousand five hundred fifty dollars and zero cents. ($ 30,550) per Lump Sum.	1 - CCA 1 - CCC	LS LS	18 330 12 220	18 330 12 220
	Division Subtotal				$ 30 550 -
THERMAL AND MOISTURE PROTECTION					
Division 7	Thermal and Moisture Protection Thirty thousand five hundred twenty five dollars and zero cents. ($ 30,525) per Lump Sum.	1 - CCA 1 - CCC	LS LS	18 315 12 210	18 315 12 210
07 81 00	Applied Fireproofing **(ALLOWANCE)** Thirty thousand dollars and zero cents. ($ 30,000) per lump sum.			$30,000.00	$30,000.00 (Include in Base Scope Total and Division Subtotal below)
	Division Subtotal				$ 30,000 -
OPENINGS					
Division 8	Openings Forty Five Thousand nine hundred twenty nine dollars and zero cents.	1 - CCA 1 - CCC	LS LS	27 557 18 372	27 557 18 372

($ 45,929) per Lump Sum.

Division Subtotal $ 45,929

FINISHES

Division 09	Finishes Five Hundred Fifty Two Thousand Four Hundred Thirty Seven dollars and NO cents. ($ 552437) per lump sum.	1 - CCA 1 - CCC	LS LS	331462 220,975	331,462 220,975

Division Subtotal $ 552437

HEATING, VENTILATING, AND AIR CONDITIONING

Division 23	Selective Demolition for Mechanical Nine Million Three Hundred Ninety Eight Thousand Five Hundred Thirty Eight dollars and NO cents. ($ 9,398,538) per Lump Sum.	1 - CCA 1 - CCC	LS LS	4829352 4569186	4829352 4569186

Division Subtotal $ 9,398,538

ELECTRICAL

Division 26	Electrical One million nine hundred thirty four thousand four hundred fifty dollars ($ 1934450) per Lump Sum.	1 - CCA 1 - CCC	LS LS	929500 1,004,950	929500 1,004,950

Division Subtotal $ 1,934,450

COMMUNICATIONS

Division 27	Communications Thirty nine thousand eight hundred twenty zero dollars and cents. ($ 39820) per Lump Sum.	1 - CCA 1 - CCC	LS LS	23054 16766	23054 16766

Division Subtotal $ 39820

ELECTRICAL SAFETY AND SECURITY

Division 28	Electrical Safety and Security One hundred twenty one thousand five hundred fifty seven dollars and cents. ($ 121,557) per Lump Sum.	1 - CCA 1 - CCC	LS LS	62874 58683	62874 58683

Division Subtotal $ 121,557

EARTHWORK

Division 31	Earthwork Two hundred fifty six thousand three hundred ninety eight dollars and cents. ($ 256398) per Lump Sum.	1 - CCA 1 - CCC	LS LS	153838 102560	153838 102560
31 63 29	Drilled Concrete Micropiles Nine Hundred Forty Seven Thousand Five Hundred Eighty Seven dollars and NO cents. ($ 947587) per lump sum.	2760 - CCA 2000 - CCC	LF LF	568552 379035	568552 379035

Division Subtotal $ 1,203,985

Base Scope Total: $ 17,100,000

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DENVER INTERNATIONAL AIRPORT

Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Data Forms
INFORMATION ABOUT CONTRACTOR

1. Name of Bidder/Contractor: PCL Construction Services, Inc.

2. Type of business entity: General Contractor
NOTE: If Bidder is a **partnership** or **joint venture**, give full names of all partners or joint venturers. Bid must be signed by all joint venturers. If Bidder is a **limited liability company**, bid must be signed by authorized manager (may be signed by member-manager if LLC is organized to allow management by members).

3. Prequalified by City and County of Denver as Construction Contractor : Categories: 2A - General Building: Unoccupied, 2B - General Building Buildings: Occupied, 1A - Heavy Civil

Monetary Limit: $50,000,000 per category

4. Address of Contractor: 2000 S. Colorado Blvd, Suite 2-500

Denver, CO 80222

2000 S. Colorado Blvd, Suite 2-500

Telephone: 303-365-6500 Fax: 303-365-6590

Email Address: denverinquiries@pcl.com

5. Established where and when: Colorado in 1984

6. Contractor's Banks: UMB Bank, John Mastro

1670 Broadway, Denver, CO 303-839-2236

7. Principal Officers of Contractor (managers and members if LLC):

Name: Ryan Schmidt Name: _____

Title: District Manager Title: _____

Name: _____ Name: _____

Title: _____ Title: _____

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8. Bidder's/Contractor's City and County of Denver Contractor License if it has obtained one:

License No.: 10664

Class: A

A contractor license is required prior to start of construction but not prior to bid submittal.

9. Bidder's/Contractor's state of incorporation (state of organization if an LLC or partnership): Colorado

10. Bidder's Surety: Fidelity and Deposit Company of Maryland & Surety Company of America and Federal Insurance Company

11. Surety's State of Incorporation: Maryland

12. Address of Contractor in other areas (if different from No. 4):

13. Name and address of person to receive payments: Kate West, Secretary/Treasurer

2000 S. Colorado Blvd, Suite 2-500

Denver, CO 80222

14. If the Bidder/Contractor is a joint venture, it shall attach a certified copy of the joint venture agreement. The joint venture agreement will not be included as a contract document.

15. The Bidder/Contractor shall identify all applicable labor agreements (if any) to be used in the performance of the Work: N/A

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Bidder PCL Construction Services, Inc.

DENVER INTERNATIONAL AIRPORT

Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Data Forms

LIST OF PROPOSED SUBCONTRACTORS WHICH ARE NOT DBE SUBCONTRACTORS

Bidder shall list below the name, business address, work assignment and dollar value of each subcontractor that is not a DBE subcontractor which will perform work or labor or provide services to the Bidder relating to this contract in an amount greater than one and one-half percent of the Bidder's total bid. Only one subcontractor for each portion of the work shall be listed. Any proposed subcontractors to be utilized by the Bidder that are certified as a Small Business Enterprise shall also be listed on the "List of Proposed Subcontractors" attached to these Bid Forms.

If the Bidder does not identify a subcontractor to perform portions of the work which could be subcontracted on this form or the List of Proposed DBE Subcontractors, the Bidder, if it is awarded the contract, agrees not to subcontract such portions that exceed one and one half percent of the total bid amount until the Contractor has advised the SVP-AIM in writing of the reasons why the subcontractor was not listed in the bid and complied with the requirements of General Condition 502.

If the Bidder is awarded the contract and does not enter into a subcontract with a subcontractor listed below or on the List of Proposed DBE Subcontractors, the Contractor agrees not to subcontract any of the work assignment identified for that subcontractor until the Contractor has advised the SVP-AIM in writing of the reasons why a different subcontractor is being used and has obtained approval of the SVP-AIM of the substitution. This requirement does not affect the applicability of 502.

Subcontractor	Work Assignment	Subcontract Dollar Value
NAME: Kumar & Associates ADDRESS: 2390 Lipan St. Denver, CO 80223 PHONE: 303 742 9700	Survey/ ITA	$3,210

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Subcontractor	Work Assignment	Subcontract Dollar Value
NAME: JOB CONCRETE ADDRESS: 13595 Shurtleff Ct. Broomfield, CO 80020 PHONE: 303-465-6032	CONCRETE	954,442
NAME: NICHOLSON ADDRESS: 5161 E. Arapahoe Rd. #420 Centennial, CO 80122 PHONE: 303-926-0411	MICROPILES	947,587
NAME: VELTRI STEEL ADDRESS: PHONE: 719-250-0503	STEEL	30,550
NAME: DH PACE ADDRESS: 4200 Monaco St. Denver, CO 80216 PHONE: 303-783-3667	OH DOORS	25,929
NAME: CO DOORWAYS ADDRESS: 5151 Bannock St. Denver CO 80216 PHONE: 303-291-0900	HM DOORS	20,000
NAME: 4K DRYWALL ADDRESS: 9062 N. 1st St. Wellington, CO 80549 PHONE: 970-484-8362	DRYWALL	305,670
NAME: WESTERN CONSTRUCTORS ADDRESS: 730 Scarlet Dr. Grand Junction, CO 81505 PHONE:	SOUND BLANKETS	167,723
NAME: RK MECHANICAL ADDRESS: 3800 Xanthia St. Denver, CO 80238 PHONE: 303-355-9696	HVAC/PLUMBING	9,398,538

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Subcontractor	Work Assignment	Subcontract Dollar Value
NAME: IME ADDRESS: 5050 Osage St. Suite #500 Denver, CO 80221 PHONE: 303-733-7248	ELECTRICAL	1,934,450
NAME: HILLEN ADDRESS: 7600 Dahlia St. Commerce City, CO 80022 PHONE: 303-287-2664	EARTHWORK/ DEMO	645,822
NAME: ADDRESS: PHONE:		
NAME: ADDRESS: PHONE:		
NAME: ADDRESS: PHONE:		
NAME: ADDRESS: PHONE:		
NAME: ADDRESS: PHONE:		

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EEO QUESTIONNAIRE
Contract No.: 201951778

1. Name of Business: PCL Construction Services, Inc.
2. Address: 2000 S Colorado Blvd Suite 2-500
3. City, State, Zip Code: Denver, CO 80222
4. Telephone Number: (303) 365-6500
5. Name and title of your firm's EEO Contact: Erin Kemp, Human Resources and Prof Development Manager
6. Are you an affiliate or a subsidiary of another business organization (branches, etc.)?
   [X] Yes [ ] No
7. Type of business you are engaged in: General Contractor
8. Does the organization have a procedure for resolving discrimination complaints?
   [X] Yes [ ] No
9. Has your firm been charged with discrimination within the past eighteen (18) months?
   [ ] Yes [X] No
10. Is your firm required to submit an EEO-1 annually to the EEOC?
    [X] Yes [ ] No
11. Are you now working or have you worked on a City and County of Denver contract during the past twelve (12) months? [X] Yes [ ] No
    If yes, complete the following information:

Type of Contract	Contract Number	Total Cost of Each Contract
Northfield Fire Station 39	201842009	$5,288,352
Re-Imagine Play at Paco Sanchez	201735349-00	$9,517,066
DEN On-Call General Construction	201735074	$15,000,000
DEN Concourse B&C Sewer Repair	201950765	$7,244,653

(You may use additional sheets if necessary)

(Page 1 of 2 pages)

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PROJECTION OF ANTICIPATED WORKFORCE
Contract No. 201951778

12. List the number of anticipated new employees needed by the contractor to perform this contract by trade/craft positions.

ANTICIPATED NUMBER OF NEW EMPLOYEES FOR THIS CONTRACT

Trade Craft	Estimated Total Manpower	Estimated Total Hours	Number of Employees Minority/Female	Total Estimated Employees Minority/Female
N/A				

13. What is the anticipated number of employees from the apparent low bidder's current work force to be utilized to perform this contract? N/A

14. Estimate manpower utilization for the project below:

ESTIMATE OF MANPOWER UTILIZATION

Trade Craft	Estimated Total Manpower	Estimated Total Hours	Number of Employees Minority/Female	Total Estimated Employees Minority/Female
Carpenter	2	3900	2	2

15. Will the estimated total manpower (anticipated new hires and current staff to be utilized on this contract) meet the City's minority employment and female employment goals?
☒ Yes ☐ No

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Bidder PCL Construction Services, Inc.

DENVER INTERNATIONAL AIRPORT

Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Data Forms
EQUAL OPPORTUNITY REPORT STATEMENT

Each Bidder shall complete and sign the Equal Opportunity Report Statement. A Bid may be considered unresponsive and may be rejected, in the Owner's sole discretion, if the Bidder fails to provide the fully executed Statement or fails to furnish required data. The Bidder shall also, prior to award, furnish such other pertinent information regarding its own employment policies and practices as well as those of its proposed subcontractors as the FAA, the Owner, or the Executive Vice Chairman of the President's Committee may require.

The Bidder shall furnish similar Statements executed by each of its first-tier and second-tier subcontractors and shall obtain similar compliance by such subcontractors, before awarding subcontracts. No subcontract shall be awarded to any non-complying subcontractor.

Equal Opportunity Report Statement
as Required in 41 CFR 60-1.7(b)

The Bidder shall complete the following statements by checking the appropriate blanks. Failure to complete these blanks may be grounds for rejection of bid:

1. The Bidder has _X_ has not ___ developed and has on file at each establishment affirmative action programs pursuant to 41 CFR 60-1.40 and 41 CFR 60-2.

2. The Bidder has _X_ has not ___ participated in any previous contract or subcontract subject to the equal opportunity clause prescribed by Executive Order 11246, as amended.

3. The Bidder has _X_ has not ___ filed with the Joint Reporting Committee the annual compliance report on Standard Form 100 (EEO-1 Report).

4. The Bidder does _X_ does not ___ employ fifty or more employees.

Dated: 04/09/2020

PCL Construction Services, Inc.
(Name of Bidder)

By: Fritz Mercer

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Title: General Contractor

Bidder PCL Construction Services, Inc.

DENVER INTERNATIONAL AIRPORT

Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Data Forms

CERTIFICATION OF NON-SEGREGATED FACILITIES
(Must be completed and submitted with the Bid)

The Bidder certifies that it does not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not permit its employees to perform their services at any location under its control, where segregated facilities are maintained. The Bidder certifies further that it will not maintain or provide for its employees segregated facilities at any of its establishments, and that it will not permit its employees to perform their services at any location under its control, where segregated facilities are maintained. The Bidder agrees that a breach of this certification is a violation of the equal opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, restrooms and washrooms, restaurants and other eating areas, parking lots, drinking fountains, recreation or entertainment areas, transportation and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom, or any other reason. The Bidder agrees that (except where it has obtained identical certification from proposed subcontractors for specific time period) it will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the equal opportunity clause, and that it will retain such certification in its files.

DATED: 04/09/2020

PCL Construction Services, Inc.
(Name of Bidder)

By: Fritz Mercer

Title: Project Manager

Reference #	12852844
Status	Complete
Business Email Address	RPSchmidt@PCL.com
Enter Email Address of City and County of Denver contact person facilitating this solicitation.	contract.procurement@flydenver.com
Please provide the City Agency that is facilitating this solicitation:	Denver International Airport
Project Name	Concourse A & C Pre-Conditioned Air Re-Life
Solicitation No. (Check Below if Not Applicable)	201951778
Name of Your Company	PCL Construction Services, Inc
What Industry is Your Business?	Construction/Landscape/Maintenance Services
Address	2000 S Colorado Blvd., Ste 2-500
City	Denver
State	Colorado
Zip Code	80104
Business Phone Number	303-365-6500
1. How many employees does your company employ?	Over 100
Number of Full Time:	165
Number of Part Time:	0
2. Do you have a Diversity and Inclusiveness Program?	Yes
2.1. Employment and retention?	Yes
2.2. Procurement and supply chain activities?	Yes
2.3. Customer Service?	Yes
3. Provide a detailed narrative of your company's diversity and inclusiveness principles and programs. This may include, for example, (i) diversity and inclusiveness employee training programs, equal opportunity policies, and the budget amount spent on an annual basis for workplace diversity; or (ii) diversity and inclusiveness training and information to improve customer service. (If Not Applicable, please type N/A below)	PCL values diversity in our clients, projects, workforce, and business partners. We recognize that inclusive practices within our workforce and business partnerships position PCL to advance and sustain our position as a world-class builder by leveraging diverse talent and expertise, backgrounds, and perspectives. Across our organization, our business units employ best practices to meet the diversity and inclusion objectives of PCL, as well as of the clients and communities we serve. Diversity and Inclusion practices align with the core values and guiding principles of the company and have been underway for

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a number of years. PCL's diversity and inclusion programs, practices, and training are implemented and executed by the company's US Director of Diversity and Inclusion with oversight by our executive leadership team.

Corporate Diversity & Inclusion Statement
We've always known that people are our greatest asset.

Construction is a complicated business, and our success requires the skills and efforts of a diverse group of people, engaged in a wide variety of activities. Our 100-plus-year tradition of construction excellence is attributable to the efforts of people from different cultures and backgrounds and with different beliefs. PCL values the additional perspectives, solutions, and ideas that come from a diverse workforce. We recognize that these factors allow us to better achieve company objectives and meet the needs of our customers.

We value diversity and are intentionally inclusive in the areas of:

-Talent
PCL recognizes diversity as a competitive advantage and is focused on attracting and retaining the industry's best talent through recruitment, engagement, and career development practices. This provides equitable opportunities for contribution, growth, and advancement.
-Workplace
PCL aspires to be a workplace that represents the diverse communities in which we work, striving to promote a culture that fosters a sense of belonging, equity, mutual respect, and ownership through people, processes, and programs.
-Industry
PCL delivers value for our clients by leveraging diverse, industry-leading talent charged with providing solutions through innovative thinking, partnerships, and collaboration.
-Community
PCL invests in the communities we serve, in the spirit of stewardship and volunteerism, through representation, involvement, and investment. We support community-based organizations that provide education, training, and career assistance to diverse groups of people.
PCL is an equal opportunity employer and will not discriminate against any applicant, employee, vendor or business partner because of race, religion, color, gender, sexual orientation, physical or mental disability, age, ancestry, place of origin, national origin, marital status, family status, or veteran status.

What binds us all together, regardless of jobs or personal characteristics, is a shared set of core values: honesty, integrity, respect, passion, and the development of a dynamic culture where everyone can learn, teach, improve, and add value for our customers.

At PCL, We Choose to Include.

Corporate Employee Diversity Program – Key Initiatives:
Our employee diversity programs address recruitment, engagement, advancement, and
retention of diverse individuals, as well as veterans and service members. Under the leadership of PCL's Director of Diversity and Inclusion, we continue to advance our strategies and efforts to promote workplace diversity to meet industry and organizational demands. Current efforts include:

Recruitment
•Partnering and sponsoring diverse student and professional industry organizations to engage diverse potential candidates
•Targeting and attending diversity-focused career fairs to increase pool of qualified diverse candidates
•Leveraging our social media presence (LinkedIn, Twitter, Facebook, etc.) to share events and key messages that reflect our diversity and inclusion objectives
•Encouraging women and diverse employees to provide referrals of other qualified candidates interested in pursuing a career at PCL
• Supporting organizations focused on providing STEM and construction education and career opportunities to girls and historically under-represented youth

Internal Engagement
•Targeted programming designed to promote and increase diverse representation at all levels of the company (Women's Leadership Summit, Diversity in Golfing initiative, Veteran Engagement Task Force)
•Development of a central internal webpage providing access to diversity-focused education, awareness, and resource materials
•Conducting internal campaigns such as Women in Construction Week (Aligned with the National Association of Women in Construction's March celebration) to spotlight the contributions and career achievements made by women of PCL
•Promotion of employee involvement in volunteer opportunities in community organizations and events focused on education, training, and support of women, diverse individuals, and veterans/service members

Advancement/Retention
•Modification of the company's internal professional/leadership development program to a more inclusive model. The PCL Leadership Academy has recently transitioned into a self-nominating program that is accessible to all eligible employees interested in participating (and not limited only to those nominated by management).
•Ongoing development of employee mentoring and sponsorship programming to increase visibility, access, and advancement opportunities to women, diverse individuals, and veterans/service members employed by PCL
•Consistent assessment of corporate climate and employee engagement through periodic formal companywide engagement surveys
•Integration of diversity and inclusion themes into new and existing training and leadership development curriculum

	The targeted budget for 2019 for diversity and inclusion initiatives, education, industry organization memberships, and contributions was $85,000. A comparable budget has been proposed for 2020.
4. Does your company regularly communicate its diversity and inclusiveness policies to employees?	Yes
If you answered Yes to Question 4, how does your company regularly communicate its diversity and inclusiveness policies to employees? (Select all that apply)	Employee Training Public EEO Postings Other (Periodic publication in weekly corporate email and intranet, initiatives and campaigns)
5. How often do you provide training and diversity and inclusiveness principles?	Other (Upon hire, and as part of a rotating corporate training/professional development schedule)
5.1 What percentage of the total number of employees generally participate?	51-75%
6. State how you achieve diversity and inclusiveness in supply and procurement activities. This may include,for example, narratives of training programs, equal opportunity policies, diversity or inclusiveness partnership programs, mentoring and outreach programs, and the amount and description of budget spent on an annual basis for procurement and supplier diversity and inclusiveness. (If Not Applicable, please type N/A below)	PCL Supplier Diversity Statement PCL values diversity in our clients, workforce, and partners. We consistently seek relationships with suppliers and subcontractors that advance our efforts to deliver exceptional services and performance to our clients. In addition, we strive to form strong bonds within the communities where we work and live. PCL staff involved in purchasing and subcontracting are encouraged to identify and include diverse suppliers and subcontractors in the procurement process. Our goal is to promote inclusive practices that provide maximum opportunity to all companies that meet our purchasing and contracting standards, while: •Increasing our pool of small, minority, and woman-owned business partners, while maintaining current standards of safety, quality, competitive pricing, and project delivery •Ensuring that small, minority, and woman-owned businesses are treated fairly during the procurement process •Helping small and diverse businesses understand PCL’s supplier/subcontractor related policies and procedures •Encouraging small and diverse businesses to become certified through the appropriate regional, national, and industry organizations Supplier diversity classifications include: Small/Disadvantaged, Small, Minority, Women, Veteran, Service-Disabled Veteran, Historically Underutilized Business Zone, Nonprofits, Alaskan Native Corporations/Indian Tribes, LGBT, physically challenged or disabled, and other protected groups. Supplier Diversity Activities

Our supplier diversity engagement efforts include outreach, subcontractor mentorship and development, and procurement processes designed to maximize small/diverse company participation. As a company, we are committed to supporting diverse, historically underutilized, and disadvantaged business enterprises. In addition, we support community-based organizations that provide education, training and assistance to diverse individuals and businesses.

Outreach/Engagement

PCL understands the importance of providing access to opportunities through outreach to small and diverse businesses. Our outreach efforts include:
•Frequent communications via multiple channels to provide businesses with information on outreach activities and subcontracting opportunities
•Large- and small-scale outreach events to build relationships with local small/diverse businesses and provide guidance on PCL prequalification and solicitation processes
•Vendor Database - Small and diverse businesses are encouraged to register in our Supplier Database to alert us of their interest in pursuing business/opportunities with PCL and provide basic information that assists us in soliciting bids.
•Membership/participation in local small and diverse business organizations
•Subcontractor mentorship and development: We are committed to the success of our small/diverse business partners and seek opportunities to provide mentoring and guidance on industry best practices in safety, quality, and project execution.

Procurement processes to maximize small/diverse company participation:

•Packaging break-down to identify opportunities that match capabilities within the community
•Maintaining a directory of resources to serve as a reference point for firms seeking assistance and support services
•Facilitating relationships and opportunities between subcontractors and for small businesses through networking and referrals
•Pre-bid screening to identify insurance, liability claims, safety histories, and financial issues that have the potential of impacting bid participation and performance

In addition to our external engagement efforts, we employ a number of streamlined processes designed to ensure small business success, including:

•Subcontractor Default Insurance
•Electronic payment system for expedited payments
•Periodic check-ins with small/diverse business partners to ensure early identification and resolution of issues that may arise

Annual budget expenditures for procurement and supplier

	diversity and inclusiveness are based on project and pursuit load, but average approximately $25,000 per year. Supplier diversity budgets are allocated based on anticipated expenditures for large and small scale outreach events, diverse business organization membership dues, and other engagement activities (such as sponsored workshops).
7. Do you have a diversity and inclusiveness committee?	Yes
7.1 If Yes, how often does it meet?	Other (PCL has a US Diversity Taskforce and is in the process to create a new diversity and inclusion counsel with local committees)
8. Do you have a budget for diversity and inclusiveness efforts?	Yes
9. Does your company integrate diversity and inclusion competencies into executive/manager performance evaluation plans?	No
I attest that the information represented herein is true, correct and complete, to the best of my knowledge.	Check Here if the Above Statement is True.
Name of Person Completing Form	Erin Kemp
Today's Date	03-24-2020
Last Update	2020-03-24 16:10:02
Start Time	2020-03-24 10:55:04
Finish Time	2020-03-24 16:10:02
IP	76.120.57.145
Browser	IE
OS	Windows
Referrer	https://fs7.formsite.com/CCDenver/form161/index.html

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Form **W-9**
(Rev. October 2018)
Department of the Treasury
Internal Revenue Service

Request for Taxpayer Identification Number and Certification

▶ **Go to *www.irs.gov/FormW9* for instructions and the latest information.**

Give Form to the requester. Do not send to the IRS.

Print or type. See Specific Instructions on page 3.

1 Name (as shown on your income tax return). Name is required on this line; do not leave this line blank.

PCL Construction Services, Inc

2 Business name/disregarded entity name, if different from above

3 Check appropriate box for federal tax classification of the person whose name is entered on line 1. Check only **one** of the following seven boxes.

☐ Individual/sole proprietor or single-member LLC ☑ C Corporation ☐ S Corporation ☐ Partnership ☐ Trust/estate

☐ Limited liability company. Enter the tax classification (C=C corporation, S=S corporation, P=Partnership) ▶ _____

Note: Check the appropriate box in the line above for the tax classification of the single-member owner. Do not check LLC if the LLC is classified as a single-member LLC that is disregarded from the owner unless the owner of the LLC is another LLC that is **not** disregarded from the owner for U.S. federal tax purposes. Otherwise, a single-member LLC that is disregarded from the owner should check the appropriate box for the tax classification of its owner.

☐ Other (see instructions) ▶

4 Exemptions (codes apply only to certain entities, not individuals; see instructions on page 3):

Exempt payee code (if any) _____

Exemption from FATCA reporting code (if any) _____

(Applies to accounts maintained outside the U.S.)

5 Address (number, street, and apt. or suite no.) See instructions.

2000 S. Colorado Blvd., 2-500

Requester's name and address (optional)

6 City, state, and ZIP code

Denver, CO 80222

7 List account number(s) here (optional)

Part I Taxpayer Identification Number (TIN)

Enter your TIN in the appropriate box. The TIN provided must match the name given on line 1 to avoid backup withholding. For individuals, this is generally your social security number (SSN). However, for a resident alien, sole proprietor, or disregarded entity, see the instructions for Part I, later. For other entities, it is your employer identification number (EIN). If you do not have a number, see *How to get a TIN,* later.

Note: If the account is in more than one name, see the instructions for line 1. Also see *What Name and Number To Give the Requester* for guidelines on whose number to enter.

Social security number

			–			–				

or

Employer identification number

8	4	–	0	9	5	7	5	5	2

Part II Certification

Under penalties of perjury, I certify that:

1. The number shown on this form is my correct taxpayer identification number (or I am waiting for a number to be issued to me); and
2. I am not subject to backup withholding because: (a) I am exempt from backup withholding, or (b) I have not been notified by the Internal Revenue Service (IRS) that I am subject to backup withholding as a result of a failure to report all interest or dividends, or (c) the IRS has notified me that I am no longer subject to backup withholding; and
3. I am a U.S. citizen or other U.S. person (defined below); and
4. The FATCA code(s) entered on this form (if any) indicating that I am exempt from FATCA reporting is correct.

Certification instructions. You must cross out item 2 above if you have been notified by the IRS that you are currently subject to backup withholding because you have failed to report all interest and dividends on your tax return. For real estate transactions, item 2 does not apply. For mortgage interest paid, acquisition or abandonment of secured property, cancellation of debt, contributions to an individual retirement arrangement (IRA), and generally, payments other than interest and dividends, you are not required to sign the certification, but you must provide your correct TIN. See the instructions for Part II, later.

Sign Here | **Signature of U.S. person ▶** [signature] **Date ▶** 2/5/2019

General Instructions

Section references are to the Internal Revenue Code unless otherwise noted.

Future developments. For the latest information about developments related to Form W-9 and its instructions, such as legislation enacted after they were published, go to *www.irs.gov/FormW9.*

Purpose of Form

An individual or entity (Form W-9 requester) who is required to file an information return with the IRS must obtain your correct taxpayer identification number (TIN) which may be your social security number (SSN), individual taxpayer identification number (ITIN), adoption taxpayer identification number (ATIN), or employer identification number (EIN), to report on an information return the amount paid to you, or other amount reportable on an information return. Examples of information returns include, but are not limited to, the following.

- Form 1099-INT (interest earned or paid)
- Form 1099-DIV (dividends, including those from stocks or mutual funds)
- Form 1099-MISC (various types of income, prizes, awards, or gross proceeds)
- Form 1099-B (stock or mutual fund sales and certain other transactions by brokers)
- Form 1099-S (proceeds from real estate transactions)
- Form 1099-K (merchant card and third party network transactions)
- Form 1098 (home mortgage interest), 1098-E (student loan interest), 1098-T (tuition)
- Form 1099-C (canceled debt)
- Form 1099-A (acquisition or abandonment of secured property)

Use Form W-9 only if you are a U.S. person (including a resident alien), to provide your correct TIN.

If you do not return Form W-9 to the requester with a TIN, you might be subject to backup withholding. See What is backup withholding, *later.*

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DENVER
ECONOMIC DEVELOPMENT & OPPORTUNITY

COMMITMENT TO DBE PARTICIPATION

Division of Small Business Opportunity
Denver International Airport
Compliance Unit
Main Terminal, Level 6
Denver, CO 80249
Phone: 303-342-2180
DSBO@flydenver.com

The undersigned has satisfied the DBE participant requirements in the following manner (Please check the appropriate box):

☒ The Bidder/Proposer is committed to the minimum of 15 % **DBE** utilization on the project, and will submit Letters of Intent (LOI) for each subcontractor/subconsultant listed in the Bid Forms as follows:
Hard Bids: Five (5) business days after the bid opening.
Request for Proposals/Qualifications: With the proposal when due.

☐ The Bidder/Proposer is unable to meet the project goal of _____% **DBE,** but is committed to a minimum of _____% **DBE** utilization on the project. The Bidder/Proposer understands that they must submit a detailed statement of their good faith effort under sealed bid procedures, as a matter of responsiveness, or with initial proposals, under contract negotiation procedures; or no later than **five (5)** days after bid opening as a matter of responsibility as in accordance with regulations of the U.S. Department of Transportation, 49 CFR Part 26 §26.53

☐ The Bidder/Proposer is a certified **DBE** in good standing with the City and is committed to self-perform a minimum of **30%** of the work on the contract.

Bidder/Proposer (Name of Firm): PCL Construction Services, Inc.

Firm's Representative (Please print): Fritz Mercer

Signature (Firm's Representative):

Title: Project Manager

Address: 2000 S. Colorado Blvd. Suite 2-500

City: Denver	State:CO	Zip:80222
Phone:303-365-6500	Fax:303-365-6590	Email: fymercer@pcl.com

A copy of the DBE Certification letter must be attached to each Letter of Intent (LOI).

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DENVER
ECONOMIC DEVELOPMENT & OPPORTUNITY

List of Proposed DBE Bidders, Subcontractors, Suppliers (Manufacturers) or Brokers

Division of Small Business Opportunity
Denver International Airport
Compliance Unit
Main Terminal, Level 6
Denver, CO 80249
Phone: 303-342-2180
DSBO@flydenver.com

City & County of Denver Contract No.: 201951778 Conc A & C Pre-Conditioned Air Re-Life

The undersigned Bidder proposes to utilize all listed firms. The following DBE(s) firms listed are **CURRENTLY** certified by the City and County of Denver or UCP. Only the level of DBE participation listed at the bid opening will count toward satisfaction of the project goal. Only bona fide commisions may be counted for Brokers. DBE prime bidders must detail their bid information below. Please copy and attach this page to list additional DBE.

Non-Certified Prime Bidder

Business Name: PCL Construction Services, Inc.		
Address: 2000 S Colorado Blvd Suite 2-500 Denver, CO 80222	Contact Person: Fritz Mercer	
Type of Service: General Contractor	Dollar Amount: $:	Percent of Project:

Certified DBE Prime Bidder

Business Name:		
Address:	Contact Person:	
Type of Service:	Dollar Amount: $:	Percent of Project:

Subcontractors, Suppliers Manufacturers or Brokers (check one box)

	Subcontractor (√) ✓		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name: Quality Linings + Painting							
Address: 8250 E 40th Ave Denver, CO 80207		Type of Service: Painting					
Contact Person: Seth Pickney		Dollar Amount: $: 65,607.				Percent of Project: .031	

	Subcontractor (√) ✓		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name: NPW Contracting							
Address: 444 Sante Fe Drive Denver, CO 80204		Type of Service: Joint Sealants					
Contact Person: Helen Madden-Weiss		Dollar Amount: $: 30,525				Percent of Project: .0017	

	Subcontractor (√) ✓		Supplier (√)		Manufacturer (√)		Broker (√)
Business Name:							
Address:		Type of Service:					
Contact Person:		Dollar Amount: $:				Percent of Project:	

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Subcontractors, Suppliers Manufacturers or Brokers (check one box)			
Subcontractor (√) ✓	Supplier (√)	Manufacturer (√)	Broker (√)
Business Name: Hilen Corp			
Address: 7600 Dahlia commerce City, CO 80022	Type of Service: Earthwork + Demo		
Contact Person: Scott Heldt	Dollar Amount: $: 615,827	Percent of Project:	
Subcontractor (√) ✓	Supplier (√)	Manufacturer (√)	Broker (√)
Business Name: RK Mechanical			
Address: 3800 Xanthia St. Denver, CO 80238	Type of Service: Mechanical		
Contact Person: John Timmer	Dollar Amount: $: 2,819,100	Percent of Project: 16.48%	
Subcontractor (√) ✓	Supplier (√)	Manufacturer (√)	Broker (√)
Business Name: IME			
Address: 5050 Osage St. suite 500 Denver, CO 80221	Type of Service: Electrical		
Contact Person: George Griffiths	Dollar Amount: $: 440,124	Percent of Project: 2.57%	
Subcontractor (√)	Supplier (√)	Manufacturer (√)	Broker (√)
Business Name:			
Address:	Type of Service:		
Contact Person:	Dollar Amount: $:	Percent of Project:	
Subcontractor (√)	Supplier (√)	Manufacturer (√)	Broker (√)
Business Name:			
Address:	Type of Service:		
Contact Person:	Dollar Amount: $:	Percent of Project:	
Subcontractor (√)	Supplier (√)	Manufacturer (√)	Broker (√)
Business Name:			
Address:	Type of Service:		
Contact Person:	Dollar Amount: $:	Percent of Project:	
Subcontractor (√)	Supplier (√)	Manufacturer (√)	Broker (√)
Business Name:			
Address:	Type of Service:		
Contact Person:	Dollar Amount: $:	Percent of Project:	

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A bidder or offeror must complete and submit the Buy America certification included herein with their bid or offer. The Owner will reject as nonresponsive any bid or offer that does not include a completed Certificate of Buy American Compliance.

A4.3.2 Certificate of Buy American Compliance – Total Facility

CERTIFICATE OF BUY AMERICAN COMPLIANCE FOR TOTAL FACILITY

As a matter of bid responsiveness, the bidder or offeror must complete, sign, date, and submit this certification statement with its proposal. The bidder or offeror must indicate how it intends to comply with 49 USC § 50101 by selecting one of the following certification statements. These statements are mutually exclusive. Bidder must select one or the other (i.e. not both) by inserting a checkmark (☐) or the letter "X".

☒ Bidder or offeror hereby certifies that it will comply with 49 USC § 50101 by:

a) Only installing steel and manufactured products produced in the United States; or
b) Installing manufactured products for which the Federal Aviation Administration (FAA) has issued a waiver as indicated by inclusion on the current FAA Nationwide Buy American Waivers Issued listing; or
c) Installing products listed as an Excepted Article, Material or Supply in Federal Acquisition Regulation Subpart 25.108.

By selecting this certification statement, the bidder or offeror agrees:

- To provide to the Owner evidence that documents the source and origin of the steel and manufactured product.
- To faithfully comply with providing U.S. domestic products.
- To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

☐ The bidder or offeror hereby certifies it cannot comply with the 100 percent Buy American Preferences of 49 USC § 50101(a) but may qualify for either a Type 3 or Type 4 waiver under 49 USC § 50101(b). By selecting this certification statement, the apparent bidder or offeror with the apparent low bid agrees:

a) To the submit to the Owner within 15 calendar days of the bid opening, a formal waiver request and required documentation that supports the type of waiver being requested.
b) That failure to submit the required documentation within the specified timeframe is cause for a non-responsive determination that may result in rejection of the proposal.
c) To faithfully comply with providing U.S. domestic products at or above the approved U.S. domestic content percentage as approved by the FAA.
d) To furnish U.S. domestic product for any waiver request that the FAA rejects.

To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

Required Documentation

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Type 3 Waiver – The cost of components and subcomponents produced in the United States is more than 60 percent of the cost of all components and subcomponents of the "facility". The required documentation for a Type 3 waiver is:

a) Listing of all manufactured products that are not comprised of 100 percent U.S. domestic content (excludes products listed on the FAA Nationwide Buy American Waivers Issued listing and products excluded by Federal Acquisition Regulation Subpart 25.108; products of unknown origin must be considered as non-domestic products in their entirety).
b) Cost of non-domestic components and subcomponents, excluding labor costs associated with final assembly and installation at project location.
c) Percentage of non-domestic component and subcomponent cost as compared to total "facility" component and subcomponent costs, excluding labor costs associated with final assembly and installation at project location.

Type 4 Waiver – Total cost of project using U.S. domestic source product exceeds the total project cost using non-domestic product by 25 percent. The required documentation for a Type 4 of waiver is:

a) Detailed cost information for total project using U.S. domestic product
b) Detailed cost information for total project using non-domestic product

False Statements: Per 49 USC § 47126, this certification concerns a matter within the jurisdiction of the Federal Aviation Administration and the making of a false, fictitious or fraudulent certification may render the maker subject to prosecution under Title 18, United States Code.

04/30/2020	
Date	Signature
PCL Construction Services, Inc.	District Manager
Company Name	Title

A4.3.3 Certificate of Buy American Compliance – Manufactured Product

Certificate of Buy American Compliance for Manufactured Products

As a matter of bid responsiveness, the bidder or offeror must complete, sign, date, and submit this certification statement with their proposal. The bidder or offeror must indicate how they intend to comply with 49 USC § 50101 by selecting one on the following certification statements. These statements are mutually exclusive. Bidder must select one or the other (not both) by inserting a checkmark (☐) or the letter "X".

☒ Bidder or offeror hereby certifies that it will comply with 49 USC § 50101 by:

a) Only installing steel and manufactured products produced in the United States;

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b) Installing manufactured products for which the Federal Aviation Administration (FAA) has issued a waiver as indicated by inclusion on the current FAA Nationwide Buy American Waivers Issued listing; or
c) Installing products listed as an Excepted Article, Material or Supply in Federal Acquisition Regulation Subpart 25.108.

By selecting this certification statement, the bidder or offeror agrees:

1. To provide to the Owner evidence that documents the source and origin of the steel and manufactured product.
2. To faithfully comply with providing U.S. domestic product.
3. To furnish U.S. domestic product for any waiver request that the FAA rejects
4. To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

☐ The bidder or offeror hereby certifies it cannot comply with the 100 percent Buy American Preferences of 49 USC § 50101(a) but may qualify for either a Type 3 or Type 4 waiver under 49 USC § 50101(b). By selecting this certification statement, the apparent bidder or offeror with the apparent low bid agrees:

1. To the submit to the Owner within 15 calendar days of the bid opening, a formal waiver request and required documentation that supports the type of waiver being requested.
2. That failure to submit the required documentation within the specified timeframe is cause for a non-responsive determination may result in rejection of the proposal.
3. To faithfully comply with providing U.S. domestic products at or above the approved U.S. domestic content percentage as approved by the FAA.
4. To refrain from seeking a waiver request after establishment of the contract, unless extenuating circumstances emerge that the FAA determines justified.

Required Documentation

Type 3 Waiver – The cost of the item components and subcomponents produced in the United States is more that 60 percent of the cost of all components and subcomponents of the "item". The required documentation for a Type 3 waiver is:

a) Listing of all product components and subcomponents that are not comprised of 100 percent U.S. domestic content (Excludes products listed on the FAA Nationwide Buy American Waivers Issued listing and products excluded by Federal Acquisition Regulation Subpart 25.108; products of unknown origin must be considered as non-domestic products in their entirety).
b) Cost of non-domestic components and subcomponents, excluding labor costs associated with final assembly at place of manufacture.
c) Percentage of non-domestic component and subcomponent cost as compared to total "item" component and subcomponent costs, excluding labor costs associated with final assembly at place of manufacture.

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Type 4 Waiver – Total cost of project using U.S. domestic source product exceeds the total project cost using non-domestic product by 25 percent. The required documentation for a Type 4 of waiver is:

a) Detailed cost information for total project using U.S. domestic product
b) Detailed cost information for total project using non-domestic product

False Statements: Per 49 USC § 47126, this certification concerns a matter within the jurisdiction of the Federal Aviation Administration and the making of a false, fictitious or fraudulent certification may render the maker subject to prosecution under Title 18, United States Code.

04/30/2020	
Date	Signature
PCL Construction Services, Inc.	District Manager
Company Name	Title

A5 CIVIL RIGHTS – GENERAL

A5.3.1 GENERAL CIVIL RIGHTS PROVISIONS

The 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 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.

A6 CIVIL RIGHTS – TITLE VI ASSURANCE

A6.3.1 Title VI Solicitation Notice

The **(Name of Sponsor)**, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 USC §§ 2000d to 2000d-4) and the Regulations, hereby notifies all bidders or offerors that it will affirmatively ensure that any contract entered into pursuant to this advertisement, [select disadvantaged business enterprises or airport concession disadvantaged business enterprises] will be afforded full and fair opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award.

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DENVER INTERNATIONAL AIRPORT
Concourse A & C Pre-Conditioned Air Re-Life
Contract No. 201951778

Bid Bond

KNOW ALL MEN BY THESE PRESENTS

THAT PCL Construction Services, Inc. as Principal, and Fidelity and Deposit Company of Maryland, a corporation organized and existing under and by virtue of the laws of the State of IL, and authorized to do business within the State of Colorado as Surety, are held and firmly bound unto the City and County of Denver, Colorado, as Obligee, in the full and just sum of Five Percent of Amount Bid Dollars and _____ Cents ($ 5% of Amount Bid) lawful money of the United States, for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents:

WHEREAS, the said Principal is herewith submitting its Bid, dated on APRIL 30, 2020 for the construction of Contract No. 201951778, Concourse A & C Pre-Conditioned Air Re-Life, Denver International Airport, as set forth in detail in the contract documents for the City and County of Denver, Colorado, and said Obligee has required as a condition for receiving said Bid that the Principal deposit specified bid security in the amount of not less than five percent (5%) of the amount of said Bid, as it relates to work to be performed for the City, conditioned that in event of failure of the Principal to execute the Contract for such construction and furnish required Performance and Payment Bond if the Contract is offered him, that said sum be paid immediately to the Obligee as liquidated damages, and not as a Penalty, for the Principal's failure to perform.

The condition of this obligation is such that if the aforesaid Principal shall, within the period specified therefor, on the prescribed form presented to him for signature, enter into a written Contract with the Obligee in accordance with his bid as accepted, and give Performance and Payment Bond with good and sufficient surety or sureties, upon the form prescribed by the Obligee, for the faithful performance and the proper fulfillment of said Contract, or in the event of withdrawal of said bid within the time specified, or upon the payment to the Obligee of the sum determined upon herein, as liquidated damages and not as a Penalty, in the event the Principal fails to enter into said Contract and give such Performance and Payment Bond within the time specified, then this Obligation shall be null and void, otherwise to remain in full force and effect.

[END OF PAGE]

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Signed, sealed and delivered this 29th day of April, 2020

Attest:

Secretary

[SEAL if bidder a corporation]

PCL CONSTRUCTION SERVICES, INC. - COLORADO - SEAL

PCL Construction Services, Inc.

PRINCIPAL

By: ~~President~~ District Manager

Fidelity and Deposit Company of Maryland CORPORATE SEAL 1890

Fidelity and Deposit Company of Maryland

SURETY

By:

Attorney-in-Fact Sandra M. Winsted

(ATTACH POWER OF ATTORNEY)

Power of Attorney shall be certified as to the date of bid.

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

KNOW ALL MEN BY THESE PRESENTS: That the ZURICH AMERICAN INSURANCE COMPANY, a corporation of the State of New York, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, a corporation of the State of Illinois, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND a corporation of the State of Illinois (herein collectively called the "Companies"), by **Robert D. Murray, Vice President,** in pursuance of authority granted by Article V, Section 8, of the By-Laws of said Companies, which are set forth on the reverse side hereof and are hereby certified to be in full force and effect on the date hereof, do hereby nominate, constitute, and appoint **Sandra M. WINSTED, Diane M. O'LEARY, Susan A. WELSH, Judith A. LUCKY-EFTIMOV, James B. MCTAGGART, Debra J. DOYLE, Sandra M. NOWAK, Jessica B. DEMPSEY, Christina L. SANDOVAL, Kristin L HANNIGAN and Samantha CHIERICI, all of Chicago, Illinois,** EACH, its true and lawful agent and Attorney-in-Fact, to make, execute, seal and deliver, for, and on its behalf as surety, and as its act and deed: any and all bonds and undertakings, and the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Companies, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the ZURICH AMERICAN INSURANCE COMPANY at its office in New York, New York., the regularly elected officers of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at its office in Owings Mills, Maryland, and the regularly elected officers of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at its office in Owings Mills, Maryland, in their own proper persons.

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

IN WITNESS WHEREOF, the said Vice-President has hereunto subscribed his/her names and affixed the Corporate Seals of the said **ZURICH AMERICAN INSURANCE COMPANY, COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and FIDELITY AND DEPOSIT COMPANY OF MARYLAND,** this 8th day of April, A.D. 2020.

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

By: Robert D. Murray
Vice President

By: Dawn E. Brown
Secretary

State of Maryland
County of Baltimore

On this 8th day of April, A.D. 2020, before the subscriber, a Notary Public of the State of Maryland, duly commissioned and qualified, **Robert D. Murray, Vice President and Dawn E. Brown, Secretary** of the Companies, to me personally known to be the individuals and officers described in and who executed the preceding instrument, and acknowledged the execution of same, and being by me duly sworn, deposeth and saith, that he/she is the said officer of the Company aforesaid, and that the seals affixed to the preceding instrument are the Corporate Seals of said Companies, and that the said Corporate Seals and the signature as such officer were duly affixed and subscribed to the said instrument by the authority and direction of the said Corporations.

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

Constance A. Dunn, Notary Public
My Commission Expires: July 9, 2023

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EXTRACT FROM BY-LAWS OF THE COMPANIES

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

CERTIFICATE

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

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

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

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

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

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seals of the said Companies, this 29 day of April 2020.



Brian M Hodges

By: Brian M. Hodges
Vice President

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

Zurich Surety Claims
1299 Zurich Way
Schaumburg, IL 60196-1056
www.reportsfclaims@zurichna.com
800-626-4577

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CONSTRUCTION

PROJECT CLARIFICATIONS
DEN Contract #201951778
Concourse A & C Pre-Conditioned Air Re-Life

Project Information
General Contractor/Construction Manager: PCL Construction
Project Schedule: Notice to Proceed issued by XXXX

The documents used in preparing our estimate are listed below:
Project Manual – Issued for bid February 21, 2020
CCA & CCC PCA Plants Re-Life: Specifications Volume 1 November 7, 2019
CCA & CCC PCA Plants Re-Life: Specifications Volume 2 November 7, 2019
Bid Q&A – Posted to DEN (flydenver.com) current responses as of 4/30/2020
Addendum #1 March 19, 2020
Addendum #2 March 24, 2020
Addendum #3 April 6, 2020
Addendum #4 April 13, 2020

Please see Bid Form for our base bid pricing

General Clarifications

1. ~~Either say the~~This ~~-~~proposal is based on an NTP date of xx/xx/2020~~. or this proposal is valid for xx days (90?)~~
~~1.~~2. Our proposal to achieve Substantial Completion is based on a (548) calendar day duration.
~~2.~~3. Pricing is based on a standard 40-hour work week. Overtime, weekends and holidays are excluded.
~~3.~~4. Bid is based on PCL being provided an onsite space within the facility to use as an office during the contract duration.
~~4.~~5. This bid does not include any potential escalation in the prices of any materials, equipment, or services used in the performance of the Work caused directly or indirectly by the imposition of Canadian, US, or other tariffs.
~~5.~~6. ~~This COVID clause~~This Bid/Proposal does not include any potential impacts, costs, charges, delays, or other schedule changes that might arise due to the Coronavirus Disease 2019 (COVID-19) or any similar epidemic/pandemic. ~~is the long version. We only need the short version from Clarke. Let me know if you need it. This version is something we'd want inserted in a prime contract but to lengthy for Clarifications…This Budget/Estimate (revise to "bid"?proposal)does not include the following potential costs and schedule impacts that might arise due to the Coronavirus Disease 2019 (COVID-19) or similar pandemic: (1) any escalation in the prices of any materials, equipment, or services used in the performance of the Work; and (2) any schedule impacts. In the event of a change in the price of any materials, equipment, or services used in the performance of the Work (measured as the difference between the price assumed or incorporated in this Budget/Estimate and the price paid by Contractor for the materials or equipment) caused directly or indirectly by the Coronavirus Disease 2019 (COVID-19) or similar pandemic, a Change Order shall be issued changing the Contract Price/GMP to account for the difference. In the event of any schedule delays caused directly or indirectly by the Coronavirus Disease 2019 (COVID-19) or similar pandemic, a Change Order shall be issued changing the Contract Time to account for the delay and changing the Contract Price/GMP to account for costs related to the delay, including acceleration costs if acceleration is requested in order to overcome or mitigate the delay and including extended general conditions costs.~~
~~6.~~7. Delays due to permitting, hazardous material abatement, unforeseen conditions, or other factors

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CONSTRUCTION

PROJECT CLARIFICATIONS
DEN Contract #201951778
Concourse A & C Pre-Conditioned Air Re-Life

beyond the control of PCL will initiate granting of an extension of schedule and associated costs to PCL to accommodate the impacts.

~~7.~~8. Watchman Service or Security Guard Service is not included.

~~8.~~9. FAA permits are not included.

~~9.~~10. BIM coordination is based on DEN providing existing backgrounds and Revit models.

Construction Clarifications

1. Mechanical insulation is priced as furnishing and installing…..
2. Temporary power consumption fees to be paid ~~(paid for ?) provided~~ by DEN.
3. Excludes removal and replacement of any existing damaged materials not previously indicated on the bid plans, including but not limited to any water damage within the existing construction areas.
4. Excludes re-certification of existing electrical gear. Eaton (manufacturer) has indicated to electrical subcontractors that they will not perform this service per the plans.
5. Excludes permit plan review / check fees.
6. ~~Excludes installation of firestopping material by a UL or FM listed firm. I'd like to understand/discuss why we are excluding this, just for my education.~~
7. ~~7.~~6. Excludes temporary bathrooms and wash stations. Facilities existing services will be available to construction personnel. ~~. Assuming we can use DEN facilities here?~~
8. ~~8. Qualify Safety / Quality Mangers? Not sure, lets discuss in the morning.~~