

STATE OF COLORADO

DEPARTMENT OF TRANSPORTATION

Office of the Chief Engineer
Property Management Section
2829 W. Howard Place, 4th Floor
Denver, CO 80204



CRAIG HVAC UPGRADES

SAP #24724

SPECIFICATIONS

MARCH 13, 2024

Table of Contents
Craig HVAC Upgrades
March 13, 2024
CDOT # 24724



Section	Title	Pages
01 11 00	Summary of Work	1-4
01 23 00	Add Alternates	1-2
01 31 19	Project Meetings	1-4
01 33 00	Submittal Procedures	1-4
01 42 19	Reference Standards, Codes and Definitions	1-5
01 57 00	Temporary Controls	1-1
01 77 00	Closeout Procedures	1-4
01 78 23	Operation and Maintenance Data	1-6
09 21 16	Gypsum Board Assemblies	1-10
09 51 13	Acoustical Panel Ceilings	1-4
09 90 00	Painting and Coating	1-9
22 00 00	Plumbing General Requirements	1-16
22 05 00	Common Work Results for Plumbing	1-20
22 10 00	Plumbing Piping	1-5
23 00 00	HVAC General Requirements	1-12
23 05 00	Common Work Results for HVAC	1-9
23 05 93	Testing, Adjusting, and Balancing for HVAC	1-5
23 09 00	Instrumentation and Control for HVAC	1-2
23 30 00	HVAC Air Distribution	1-3
23 50 00	Central Heating Equipment	1-4
26 05 00	Common Work Results for Electrical	1-16
26 05 26	Grounding and Bonding for Electrical Systems	1-5
26 05 33	Raceway and Boxes for Electrical Systems	1-6
26 05 53	Identification for Electrical Systems	1-5
26 24 16	Panelboards	1-5
26 28 13	Fuses	1-2
26 28 16	Enclosed Switches and Circuit Breakers	1-4
	Additional Project Information:	
	Building Envelope Comcheck	1-10

DOCUMENT 000107

SEALS PAGE

1.1 DESIGN PROFESSIONALS OF RECORD

A. Architect:



B. Mechanical & Plumbing Engineer:



C. Electrical Engineer:



END OF DOCUMENT 000107

SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 PROJECT INFORMATION

- A. The Project Information and Contacts are:

1. Project Title: CRAIG HVAC UPGRADES
CDOT Project Number # 24724
2. Project Location: Colorado Department of Transportation
270 Ranney Street
Craig, CO 81625
3. Owner: (Denver) Colorado Department of Transportation
Property Management
2829 W. Howard Pl.
Denver, CO 80204
4. CDOT Representative: BENJAMIN TITUS
2829 W. Howard Pl.
Denver, CO 80204
(P) 303-903-3097
email: ben.titus@state.co.us
5. Geotechnical Engineer: N/A
6. Architect: CHAMBERLIN ARCHITECTS
Jonathan West
437 Main Street
Grand Junction, CO 81501
(P) 970-242-6804
email: jwest@chamberlinarchitects.com
7. Civil Engineer N/A
8. Structural Engineer: LINDAUER-DUNN, INC.
Frank Rinaldi
802 Rood Avenue
Grand Junction, CO 81501
(P) 970-242-0900
email: frank@lindauerdunn.com
9. Mechanical, Electrical,
Plumbing Engineer: BIGHORN CONSULTING ENGINEERS, CO.
Kyle Krauland
386 Indian Road
Grand Junction, CO 81501
(P) 970-241-8709
email: kyle@bighorneng.com

- B. The Work consists of the Architectural, Civil, Structural, Mechanical, Plumbing, and Electrical work as shown on the Drawings, specified in the Specifications, described in the Scope of Work, and as otherwise amended by Addendum prior to bidding. Bidding General Contractors to verify tie-ins to Gas, Electrical, Water and Communications prior to submitting bids.
 - 1. Work includes all labor, material, equipment, means and methods to perform the construction of all infrastructure, site work and buildings as shown on the Drawings.
- C. Geotechnical Report: N/A
- D. Submittal Log is provided as part of the Project Documents. Submittals are due from the Contractor to the CDOT Representative on the specific dates indicated. This log delineates due dates based on the Notice to Proceed date of the project. Failure to meet these deadlines will have an effect on Contractor's overall rating as part of the Contract Management System requirements.

1.3 CONTRACTOR USE OF PREMISES

- A. General: The Contractor shall have limited use of the premises during the construction period. The existing maintenance facility on site needs to continue to function during construction. Coordinate with owner before disrupting utilities to occupied structures.
- B. Limit use of premises to areas indicated or directed. Do not disturb portions of the area and site beyond the areas indicated or directed.
- C. Allow for Owner occupancy and use.
- D. Keep driveways and entrances clear. Unless directed, do not use these areas for parking or material storage. Schedule deliveries to minimize on-site storage of materials and equipment.
- E. Work currently underway at the Site: The Contractor shall be made aware if construction work is planned or is currently underway at the site.
- F. Full Owner Occupancy: The Owner will occupy and use the site during construction. Cooperate with the Owner to minimize conflicts and facilitate Owner usage. Do not interfere with the Owner's operations.
- G. Owner Provided Utilities: The Owner shall make available the following utilities for use by the Contractor during construction.
 - 1. Existing electrical; coordinate with electrical company.
- H. Contractor Provided Utilities: The Contractor shall provide for the following temporary service utilities during construction:
 - 1. Telephone
 - 2. Toilets
 - 3. Water
 - 4. Electrical Power
 - 5. Septic Permit
- I. On-Site Storage: On-Site storage will need to be arranged with CDOT at pre-construction meeting.

- J. Contractor Provided Permits and Fees: The Contractor shall provide for all permits and fees which may include, but not be limited to:
1. State Electrical and State Plumbing permits
 2. Traffic Permits
 3. Use Fees
 4. Fire Department Review by local jurisdiction, including fire alarm design review and permit if required.
 5. Colorado Department of Public Health and Environment Permits required for construction.
- K. Contractor to provide fencing around construction area to secure job site and staging, at contractor's risk.
- L. Owner pays the following fees:
1. State contracted code review, inspection fees
 2. Tap fees
 3. Electrical service upgrade fees
 4. Fire Line Connection fees, if needed

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

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SECTION 01 23 00
ADD ALTERNATES

PART 1 - GENERAL

1.1 GENERAL

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 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.

1.3 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
- B. Execute accepted alternates under the same conditions as other work of the Contract.
- C. Schedule: A schedule of alternates is included at the end of the Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Add. Alternate No. 1: TITLE OF ALTERNATE
 - 1. Base Bid: OFFICE 112 WILL REMAIN AS ONE OFFICE
 - 2. Add. Alternate: OFFICE 111 WILL BE PARTITIONED OFF BETWEEN THE EXTERIOR WINDOWS CREATING OFFICE 111 AND OFFICE 112. A NEW DOOR WILL BE ADDED TO OFFICE 1112 TO BE ACCESSED OFF OF CORRIDOR 124 AND WILL BE

IN SWINGING TO THE OFFICE. PATCH AND REPAIR WORK TO THE FLOOR, WALLS AND CEILING WILL NEED TO MATCH THE EXISTING FINISHES.

- a. KEEP EXISTING LIGHTS, WIRE THE TWO EXISTING LIGHTS IN OFFICE 112 TO A NEW LIGHT SWITCH AT THE NEW DOOR. DISCONNECT THE TWO LIGHTS IN OFFICE 112 FROM THE EXISTING LIGHT SWITCH INTO OFFICE 111

END OF SECTION

SECTION 01 31 19
PROJECT MEETINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for project meetings, including, but not limited to, the following:
1. Preconstruction Conference
 2. Construction Progress meetings
 3. Project Closeout (Punch List) meeting
 4. Project Final Inspection

1.3 CONSTRUCTION MEETINGS

- A. Preconstruction Conference: Contractor shall attend a preconstruction conference, to be held at the site of the Work, before starting construction to review responsibilities, personnel assignments, and any other pertinent construction related issues. The time of the preconstruction conference is to be determined by the CDOT Representative. CDOT Representative will provide notification to the Contractor.
1. Attendees: Authorized representatives of the CDOT, Engineer, Engineer's Sub-Consultants (as needed); the Contractor; subcontractors; and other concerned parties shall attend. Participants shall be familiar with the Project and authorized to conclude matters relating to the Work.
 2. Agenda: Discuss items that could affect progress, including, but not limited to the following:
 - a. Tentative construction schedule
 - b. Critical work sequencing
 - c. Conformance with CDOT procedures (CDOT Standard Specifications for Road and Bridge Construction, Current Edition)
 - d. Submittals
 - e. Development of Coordination Drawings
 - f. Use of the premises
 - g. Anticipated interval of subsequent construction progress meetings
 - h. Location of existing easements and requirements regarding work on, near, or under existing easements
- B. Environmental Preconstruction Conference: Prior to construction or any earthwork being performed, an on-site Environmental Preconstruction Conference shall be held. The time of the environmental preconstruction conference is to be determined by the CDOT Representative. This conference can be held concurrently with the preconstruction conference.
1. The conference shall be attended by:
 - a. The CDOT Representative
 - b. The CDOT Region Water Pollution Control Manager (RWPCM)

- c. The CDOT Personnel (e.g. CDOT Landscape Architect) who prepared or reviewed the Stormwater Management Plan (SWMP)
 - d. The Contractor's Superintendent
 - e. The Contractor's SWMP Administrator
 - f. Supervisors or Foremen of subcontractors working on the project
2. Agenda: At this conference, the attendees shall discuss the SWMP, the Colorado Department of Public Safety Stormwater Construction Permit (CDPS – SCP), sensitive habitats on site, wetlands, other vegetation to be protected, individual's responsibilities, required inspections and the enforcement mechanisms for not meeting the requirements of this specification.
- C. Construction Progress Meetings: Attend construction progress meetings at the Project Site at regular intervals as scheduled by the CDOT Representative. It is anticipated that a Construction Progress Meeting shall take place during each site observation visit that will be conducted by the CDOT Representative; contractor will notify pertinent sub-contractors.
- 1. Attendees: The CDOT Representatives, the Contractor, subcontractors; and other concerned parties shall attend. All parties concerned with current progress or involved in planning, coordination, or future activities shall be represented. Participants shall be authorized to conclude matters relating to the Work.
 - 2. Agenda: Review minutes of the previous construction progress meetings. Review items of significance that could affect progress. Include topics for discussion appropriate to Project status.

1.4 CLOSEOUT MEETINGS

- A. Project Closeout (Punch List) Meeting: Attend project closeout (punch list) meeting, to be conducted at the Project Site, after issuance of notification to the CDOT Representative of substantial completion. The timing of the project closeout (punch list) meeting shall be determined by the CDOT Representative. The CDOT Representative will provide notification to the Contractor. **The Contractor shall be made aware that a Project Closeout (Punch List) Meeting shall not be scheduled by the CDOT Representative unless, in the opinion of the CDOT Representative, the total number of minor items that are anticipated to be included on the punch list shall be ten (10) or less and include no major structural, inspection or other major issues.**
- 1. Attendees: The CDOT Representative, Architect, Engineer and their Sub-Consultants (as needed), CDOT State Buildings Delegee, the Contractor, subcontractors; Owner's code consultant and other concerned parties shall attend. All parties concerned with project closeout events. Participants shall be authorized to perform project closeout tasks.
 - 2. Agenda: Project Closeout (Punch List) Meeting is to be conducted by the CDOT Representative. Review project closeout procedures, perform Punch List walk-through of the work for the purpose of demonstrating to the Owner, Architect, Engineer, and Engineer's Sub-Consultants (as needed) and code compliance consultant that the work has been performed and completed within the guidelines set forth in the Contract Documents.
 - 3. Record Documents: During the project closeout meeting, the Contractor shall make arrangements to transfer the record documents to the CDOT Representative.
 - 4. Building Permit(s): During the project closeout meeting, the Contractor shall show evidence to the CDOT Representative that all necessary building permits have been signed off by the governing code authority on the Project's Building Inspection Report Yellow Card (State Buildings Form SBP-BIR).
 - 5. Contract Closeout Final Punch List is written by CDOT Representative and communicated to Contractor on State Buildings Form SBP 06 – Rev. 9/2006.
- B. Project Final Inspection Meeting: Project Final Inspection written by CDOT State Buildings

Delegee and communicated to Contractor.

1. Attendees: The CDOT Representative, Architect, Engineer, Sub-Consultants (as needed), CDOT State Buildings Delegee, the Contractor, subcontractors; Owner's code consultant and other concerned parties shall attend. All parties concerned with project closeout events. Participants shall be authorized to perform remaining punch list items.
2. Agenda: Final Inspection Meeting is to be conducted by the CDOT Representative. Review project closeout procedures, perform final walk-through of the work for the purpose of demonstrating to the Owner, Architect, Engineer, and Engineer's Sub-Consultants (as needed) and code compliance consultant that the punch list items has been performed and completed within the guidelines set forth in the Contract Documents.
3. Contract Closeout Final Punch List is written by Owner and communicated to Contractor on State Buildings Form SBP 06 – Rev. 9/2006.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

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SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section specifies requirements for handling submittals.

1.3 GENERAL PROCEDURES

- A. Coordinate submittal preparation with performance of construction activities, and with purchasing or fabrication, delivery, other submittals and related activities. Transmit per the due dates listed per activity on the Submittal Log provided by CDOT Representative.
- B. Coordinate transmittal of different submittals for related elements so processing will not be delayed by the need to review concurrently for coordination. Submit four (4) copies of paper submittals and/or an electronic copy, a minimum of one (1) stamped copy and/or an electronic copy will be returned to contractor. Electronic submittals are acceptable for all submittals except in the case where engineer-stamped drawings are required or color selection or material selection is required. The CDOT Representative reserves the right to withhold action on a submittal requiring coordination until all related submittals are received.
- C. Processing: Contractor shall allow ten working days beyond the date at which the submittal arrives for initial review. Allow more time if processing must be delayed for coordination with other submittals. The CDOT Representative will advise the Contractor when a submittal must be delayed for coordination.
 - 1. No extension of time will be authorized because of failure to transmit submittals sufficiently in advance of the Work to permit processing.
- D. Substitutions: Contractor may submit "like" products for review/acceptance. Contractor must provide specific documentation evidencing that proposed product meets complete specification. CDOT Representative may reject substitution. Any substitutions must comply with agreed-upon Submittal Log Date.
- E. Submittal Preparation: Place a label or title block on each submittal for identification. Include the following minimum information on the label:
 - 1. CDOT Project Name and Project Number
 - 2. Date (of transmittal to CDOT Representative)
 - 3. Name, address, and telephone number of Contractor
 - 4. Indication of review by Contractor, date, and result of review. Submittals without Contractor review stamp will not be accepted and will be returned without review.
 - 5. Specification Section and Submittal Schedule number, the products included in the

- Submittal relating to Submittal clearly referenced on the submittal package.
6. Subsequent resubmittals require a suffix to the Submittal Section number identifying the resubmittal as such.
 7. Meet agreed-upon Submittal Schedule
- F. Submittal Transmittal: Package submittals appropriately for transmittal and handling. Transmit with a transmittal form identifying the name of the Submittal and product, the Specification Section, and the Submittal Schedule number.
- G. Project-Specific Submittal Log: Owner will provide a project-specific Submittal Log to Contractor at the Project Pre-Construction Meeting. Submittals are due from Contractor to CDOT Representative on the specific dates indicated. At Pre-construction meeting, CDOT Representative will provide contractor proposed schedule of submittal due dates for review. Contractor must propose any date changes within seven (7) days of pre-construction meeting. The Submittal Log delineates due dates based on the Notice to Proceed date of the project. Failure to meet these submittal deadlines will have an effect on the Contractor's overall rating as part of the State's Contract Management System requirements.
- H. Contractor's Construction Schedule: The Contractor shall submit a written/electronic detailed construction schedule within 21 calendar days of receiving the Notice to Proceed from the CDOT Representative. Provide for separation of major construction activities. Provide starting and completion dates for major construction activities.
- I. Weekly Construction Reports: Contractor shall prepare a weekly construction report recording information concerning events at the site. Report shall be sent electronically every Friday by 8:00 a.m. recapping the current week's activities and projecting the next week's activities, for each work day. Weekly progress photos should be included with this report. Submit one copy to the CDOT Representative, electronic files are preferred. Reports shall include the following information:
1. Substantial completions.
 2. General weather conditions, if applicable.
 3. Accidents, stoppages, delays, shortages, losses. (Note: any accidents or delays/losses need to be communicated verbally to Owner at the time of incident.)
 4. Change Order Bulletins, Change Order Proposals, Change Orders, Emergency Change Orders, or Field Orders received and/or implemented. Written report does not substitute for verbal telephone communication by Contractor to CDOT Representative on any pertinent issue.
- J. Manufacturer's Operations and Maintenance Manuals/Instructions: See Section 01 78 23 Operations and Maintenance Data for more detailed information.
- K. Shop Drawings: Submit new information, drawn to accurate scale. Indicate deviations from Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Include the following information:
1. Dimensions, elevations, heights, etc.
 2. Identification of products and materials included.
 3. Notation of dimensions established by field measurement.
- L. Coordination Drawings: General Contractor is required to prepare Coordination Drawings incorporating approved product and system submittal information to include: Floor plans, reflected ceiling plans and/or building sections and details as appropriate, drawn to scale and dimensioned, and coordinating penetrations, mounting, clearances, embeds for the following, as identified by Systems:

1. General Contractor shall provide the anticipated delivery dates of Coordination Drawings Systems to be reviewed, and verify the content of the Coordination Drawings package or packages.
 2. General Contractor shall advise the CDOT Representative of conflicts in the system engineering and coordination within five (5) days after discovery of the conflict.
 3. General Contractor shall identify the subcontractor responsible for producing the Coordination Drawings within the first 30 days of the project, including the anticipated schedule for completion of each System.
 4. Coordination drawings that have been produced in a standard CADD or Revit drawing format will be provided to the CDOT Representative, Architect and Engineer as PDF files.
 5. CDOT Representative, Architect and Engineers will provide comments within five (5) days of receipt of Coordination Drawing package.
 6. Coordination Drawing System packages are each a one-time submittal, reviewed by the CDOT Representative, Architect and Engineers for compliance with design intent.
- M. Submittal: Submit electronic drawings or correctable, translucent, reproducible print(s) and one copy made from the translucent, reproducible print(s) for review if the submittal is in the form of a drawing. Submit one electronic or four identical copies for review if the submittal is in the form of cut sheets, written data, etc. Submit one sample or color chip for review if the submittal is a color selection or product sample. The reproducible print(s) (if submittal is in the form of a drawing) or one copy (if the submittal is in the form of cut sheets, written data, etc.) will be returned to the Contractor marked with action taken and corrections or modifications required after review by Architect, Owner, Engineers and Code Reviewer. The Contractor shall make all necessary copies of the returned reproducible print or copy for distribution to Sub-Contractors or affected parties. Submittals must have the stamp and signature of the Contractor, indicating the General Contractor has reviewed the Submittal prior to submission to the Architect, Owner, Engineer, and Code Reviewer. Submittals not reviewed by General Contractor will be returned un-reviewed by the CDOT Representative.
- N. Do not fabricate or install any items from Shop Drawings without a final stamp from the CDOT Representative, Architect or Engineer which indicates action to be taken (if any) by the Contractor.
- O. Product Data: Collect Product Data into a single submittal for each element or system. Mark each copy to show applicable choices and options. Where Product Data includes information on several products, some of which are not required, mark copies to indicate the applicable information. Include, as applicable, the following information:
1. Manufacturer's printed recommendations.
 2. Compliance with recognized testing agency standards and with the requirements of the Specifications.
 3. Application of testing agency labels and seals.
 4. Submittal: Submit four identical copies or an electronic copy of product data. One copy will be returned to the Contractor marked with action taken and corrections or modifications required after review by Architect, Owner, Engineers and Code Reviewer. The Contractor shall make all necessary copies of the returned submittal for distribution to Sub-Contractors or affected parties.
- P. Submittal Action: CDOT Representative, Architect, or Engineers will review each submittal, mark to indicate action taken, and return. Compliance with specified characteristics is the Contractor's responsibility.
- Q. Action Stamp: The CDOT Representative, Architect, or Engineer will stamp each submittal with an action stamp or transmittal. The stamp or transmittal will be marked to indicate action

to be taken. The review comments of the CDOT Representative, the Architect, Engineer, and/or code reviewer shall not relieve the Contractor from responsibility for deviations or errors from the Drawings or Specifications.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 01 42 19
REFERENCE STANDARDS, CODES AND DEFINITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Related Documents: Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 DEFINITIONS

- A. Indicated refers to graphic representations, notes, or schedules on the Drawings, paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. Location is not limited.
- B. Directed, requested, authorized, selected, approved, required, and permitted mean directed by the CDOT Representative, requested by the CDOT Representative, and similar phrases.
- C. Reviewed, when used in conjunction with the CDOT Representative's action on submittals, applications, and requests, is limited to the CDOT Representative's duties and responsibilities as stated in the Conditions of the Contract.
- D. Regulations include laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- E. Furnish means supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.
- F. Install describes operations at the Project Site including unloading, unpacking, assembly, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- G. Provide means to furnish and install, complete and ready for the intended use.
- H. Installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
- I. The term experienced, when used with the term Installer, means having a minimum of 5 previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of the authorities having jurisdiction.
- J. Project Site is the space available for performing construction activities, either exclusively or in conjunction, with others performing work as part of the Project.

- K. Testing Agency is an independent entity, or Geotechnical Company of Record, engaged to perform specific inspections or tests, either at the Project Site or elsewhere, or to report on and, if required, to interpret results of those inspections or tests.
- L. Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's 2004 format.
- M. Abbreviated Language: Language used in Specifications is abbreviated. Implied words and meanings shall be interpreted as appropriate. Singular words shall be interpreted as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.
- N. Imperative and streamlined language is used. Requirements expressed in the imperative mood are to be performed by the Contractor. At certain locations in the Text, subjective language is used for clarity to describe responsibilities that must be fulfilled indirectly by the Contractor, or by others when so noted.
 - 1. The words "shall be" are implied where a colon (:) is used within a sentence or phrase.
- O. Abbreviations and Names: Where acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards-generating organization, authorities having jurisdiction, or other entity applicable to the context of the text provision. Refer to the "Encyclopedia of Associations," published by Gale Research Co., available in most libraries.
- P. Permits, Licenses, and Certificates: For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments (including taxes), judgments, correspondence, records, and similar documents, established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

1.3 CODES, ORDINANCES, PERMITS AND FEES

- A. Execute work per underwriters, public utility, local, state codes, ordinances, and regulations applicable. Contact city water and sewer agencies for verification of all requirements, permits, state fees and inspections prior to submitting bid. Obtain and pay for state plumbing and state electrical required permits, inspections, utility service connections, meters and certificates. Systems development fees and similar charges are not to be included in the bid, as they will be paid directly to the utility agency by the Owner upon notification. Notify CDOT Representative of items not meeting said requirements.
- B. This Contractor shall include in the work, all labor, materials, services, apparatus and drawings, in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on drawings and /or specified.
- C. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, and with the requirements of all governmental departments having jurisdiction. In the event of a conflict, applicable codes and ordinances shall take precedence over this specification or contract drawings.
- D. All material and equipment for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriter's Laboratories, Incorporated, and shall be installed in compliance with the National Electric Code.

- E. Comply with the latest edition and/or the adopted edition of the following codes and standards as a minimum **Approved State Building Codes**:

The following approved building codes and standards have been adopted by State Buildings Programs (SBP) and other state authorities. These minimum requirements are to be applied to all construction at state agencies and institutions of higher education owned facilities including capital construction and controlled maintenance construction projects:

The 2021 edition of the International Building Code (IBC)

(As adopted by the Colorado State Buildings Program as follows: Chapter 1 as amended, Chapters 2-35 and Appendices C and I)

The 2021 edition of the International Existing Building Code (IEBC)

(As adopted by the Colorado State Buildings Program as follows: Chapters 2-16, Appendices A-C and Resource A) Effective December 2020.

The 2021 edition of the International Residential Code (IRC)

(As applicable)

The 2021 edition of the International Mechanical Code (IMC)

(As adopted by the Colorado State Buildings Program as follows: Chapters 2-15 and Appendix A)

The 2021 edition of the International Energy Conservation Code (IECC)

(As adopted by the Colorado State Buildings Program and Colorado Energy Office)

Colorado Model Electric and Solar Ready Code

(Published by the Colorado Energy Office) Effective July1, 2023

The 2023 edition of the National Electrical Code (NEC) (NFPA 70)

(As adopted by the Colorado State Electrical Board) Effective July 30, 2023

The 2021 edition of the International Plumbing Code (IPC), first printing (March 2020)

(As adopted by the Colorado Examining Board of Plumbers)

The 2021 edition of the International Fuel Gas Code (IFGC), first printing (August 2020)

(As adopted by the Colorado Examining Board of Plumbers)

The National Fire Protection Association Standards (NFPA)

(as adopted by the Department of Public Safety/Division of Fire Prevention and Control)

The 2021 edition of the International Fire Code (IFC)

(As adopted by the Department of Public Safety/Division of Fire Prevention and Control (DFPC). Projects requiring DFPC review should be designed with the most restrictive requirements)

The 2015 edition of the ASME Boiler and Pressure Vessel Code

(As adopted by the Department of Labor and Employment/Boiler Inspection Section)

The 2017 edition of the National Boiler Inspection Code (NBIC)

(As adopted by the Department of Labor and Employment/Boiler Inspection Section)

The 2015 edition of the Controls and Safety Devices for Automatically Fired Boilers CSD-1

(As adopted by the Department of Labor and Employment/Boiler Inspection Section)

The 2015 edition of the Boiler and Combustion Systems Hazards Code, NFPA 85
(As adopted by the Department of Labor and Employment/Boiler Inspection Section)

The 2019 edition of ASME A17.1 Safety Code for Elevators and Escalators
(As adopted by the Department of Labor and Employment/Conveyance Section)

The 2005 edition of ASME A17.3 Safety Code for Existing Elevators and Escalators
(As adopted by the Department of Labor and Employment/Conveyance Section)

The 2017 edition of ASME A18.1 Safety Standard for Platform Lifts and Stairway Chairlifts
(As adopted by the Department of Labor and Employment/Conveyance Section)

The current edition of the Retail Food Establishment Rules and Regulations
(As adopted by the Department of Public Health and Environment/Colorado State Board of Health and Sustainability)

The current edition of ICC/ANSI A117.1, Accessible and Usable Buildings and Facilities
(As referenced in the adopted editions of the International Building Code)

Sheet Metal and Conditioning Contractors National Assoc. Standards (SMACNA)

American Water Works Association (A.W.W.A.)

Local Utility Company Requirements

Local Governing Fire Department Requirements

National Electrical Manufacturers Association (N.E.M.A.)

Air Movement and Control Association (A.M.C.A.)

American Concrete Institute (A.C.I.)

Note: Additional codes, standards and appendices may be adopted by the state agencies and institutions in addition to the minimum codes and standards herein adopted by State Buildings Programs.

1. The 2021 edition of the IBC became effective on July 1, 2022. Consult the state electrical and plumbing boards and the state boiler inspector and conveyance administrator and the Division of Fire Prevention and Control for adoption of current editions and amendments to their codes.
2. Projects should be designed and plans and specifications should be reviewed based upon the approved codes at the time of A/E contract execution. If an agency prefers to design to a different code such as a newer edition of a code that State Buildings Programs has not yet adopted, the agency must contact SBP for approval and then amend the A/E contract with a revised Exhibit C, Approved State Building Codes. Please note that the state plumbing and electrical boards enforce the editions of their codes that are in effect at the time of permitting not design.
3. The state's code review agents, or the State Buildings Programs approved agency building official, shall review all documents for compliance with the codes stipulated herein. Note: The Department of Public Health and Environment, Division of Consumer Protection will review drawings for food service related projects.

4. This policy does not prohibit the application of various life safety codes as established by each agency for specific building types and funding requirements. NFPA 101 and other standards notwithstanding, approved codes will supersede where their minimum requirements are the most restrictive in specific situations. If a conflict arises, contact State Buildings Programs for resolution.
5. It is anticipated that compliance with the federal Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG) and Colorado Revised Statutes Section 9-5-101 will be met by compliance with the 2018 International Building Code and ICC/ANSI A117.1. However, each project may have unique aspects that may require individual attention to these legislated mandates.
6. The 2018 edition of the International Building Code (IBC) is to be applied to factory-built nonresidential structures as established by the Division of Housing within the Department of Local Affairs.
7. The superintendent shall have a current OSHA 30 certificate

F. Appendices

Appendices are provided to supplement the basic provisions of the codes. Approved IBC Appendices are as follows:

1. Mandatory
 - IBC Appendix Chapter C - Agricultural Buildings
 - IBC Appendix Chapter I - Patio Covers
2. Optional
 - Any non-mandatory appendix published in the International Building Code may be utilized at the discretion of the agency. Use of an appendix shall be indicated in the project code approach.

G. Amendments

1. International Building Code, Chapter 1 as amended

H. Referenced Standards

1. The IBC, IMC, IECC, IPC and IFGC standards shall be utilized to provide specific, or prescriptive, requirements on how to achieve the requirements established in the code. These standards may be unique to the code or may be derived from other established industry standards. Recognized standards may also be used to show compliance with the standard of duty established by the code.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 01 57 00
TEMPORARY CONTROLS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 2. Dust Control
- B. Related Sections include the following:
 - 1. Section 01 11 00: Summary of Work
 - 2. Section 01 42 19: Reference Standards, Codes and Definitions

1.3 PERFORMANCE REQUIREMENTS

- A. Dust Control
 - 1. Execute the Work by methods to minimize raising dust from construction operations.
 - 2. Provide positive means to prevent air-borne dust from dispersing into atmosphere.

PART 2 - PRODUCTS

- A. Materials shall be in accordance with Subsection 208.02 of the Standard Specification and the most recent version of the CDOT M-Standards.

PART 3 - EXECUTION

Not used.

END OF SECTION

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 COMPLETION AND ACCEPTANCE OF THE WORK

- A. The Contractor shall communicate to CDOT Representative that project is substantially complete. CDOT Representative will schedule a Project Closeout (Punch List) Meeting. The project shall be considered complete when, in the CDOT Representative's opinion, a list of incomplete work does not exceed ten (10) minor items of the Work. Should the CDOT Representative determine that the work is not complete, the CDOT Representative will immediately notify the Contractor, in writing, stating reasons why the project is not considered complete. Project is not considered complete if there are major issues outstanding or incomplete or failed inspections. Should the CDOT Representative determine that the work is complete, after the walk through; the CDOT Representative will prepare and issue a punch list of deficiencies that need to be corrected before final acceptance. After Contractor brings the project into a state of completion, a Final Inspection Meeting shall be set up by the CDOT Representative. The Contractor is made aware that all additional costs associated with re-inspection shall be paid from monies otherwise earned by the Contractor. These costs shall include the CDOT Representative's labor (time) and all associated costs of travel to the project site to attend the follow-up Project Closeout (Punch List) Meeting.

1.3 RECORD DRAWINGS

- A. Maintain a clean, undamaged set of Contract Drawings. Mark-up these drawings to show the actual installation. Give particular attention to concealed elements that would be difficult to measure and record at a later date. The Record Drawings shall be kept current and shall be marked-up as necessary during the course of executing the Work. If requested by the CDOT Representative, the Contractor shall show evidence that the Record Drawings are current as a precedent to approval of Contractor Payment Applications.

1.4 RECORD SPECIFICATIONS, FINAL AS-BUILT PLANS

- A. Maintain one copy of the Project Contract, including addenda. Mark to show variations in actual Work performed in comparison with the Specifications and modifications. The Record Specifications shall be kept current and shall be marked-up as necessary during the course of executing the Work. Give particular attention to substitutions, selection of options and similar information on elements that are concealed or cannot be readily discerned later by direct observation. If requested by the CDOT Representative, the Contractor shall show evidence that the Record Specifications are current as a precedent to approval of Contractor Payment Applications.

- B. Upon completion of Project, one (1) paper copy, and two (2) electronic PDF versions on a USB storage drive, of final, accurate as-built drawings and survey shall be delivered to the

CDOT Representative. This complete submittal shall include all drawings, including architectural, structural, civil, mechanical, electrical, plumbing and fire.

1.5 SYSTEM COMMISSIONING

- A. Prior to Project Closeout, HVAC testing, adjusting and balancing and lighting system functional testing must be completed in accordance with the IECC Section C408 and shown to be compliant with drawings and specifications. Contractor shall submit reports to owner and code reviewer at the Project Closeout meeting.
 - 1. HVAC testing shall be provided by the contractor at the Contractor's cost in accordance with Section 23 05 93 Testing, Adjusting and Balancing.

1.6 OPERATIONS AND MAINTENANCE (O & M) MANUAL

- A. Refer to Section 01 78 23, Operations & Maintenance Data, for further information on O & M specifics.

1.7 START-UP, OPERATING AND MAINTENANCE TRAINING AND INSTRUCTION

- A. Unless directed otherwise in Divisions 11, 13, 22, 23 or 26, the Contractor shall arrange for training and instruction of the Owner's personnel in proper start-up, operation and maintenance procedures for all devices and equipment installed in this contract. All training and instruction is intended to be completed in one session, however, at the mutual consent of the Contractor and Owner, more than one session may take place. Schedule training with CDOT Representative, most likely to take place on the day of the Substantial Completion Walk Through. The total length of the training and instruction session(s) shall not exceed 8 hours unless mutually agreed upon by the Owner and the Contractor. Training and instruction in excess of 8 hours shall not be compensated by the Owner. Training and Instruction shall include, but not be limited to, the following topics:
 - 1. Start-up procedures
 - 2. Operating instructions
 - 3. Shut-down procedures
 - 4. Review of Operating and Maintenance manuals

1.8 FINAL CLEANING

- A. Complete the following before providing notification that the work is complete:
 - 1. Remove labels that are not permanent labels.
 - 2. Clean exposed hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances.
 - 3. Clean the site of rubbish, litter and other foreign substances. See Special Conditions.
- B. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Remove waste materials from the site and dispose of in a lawful manner.

PART 2 - PART 2 - PRODUCTS (Not Applicable)

PART 3 - PART 3 - EXECUTION (Not Applicable)

END OF SECTION

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SECTION 01 78 23
OPERATIONS AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

- 1. Operation manuals for systems and equipment
- 2. Maintenance manuals for the care and maintenance of systems and equipment

- B. Related Sections include the following:

- 1. Section 01 33 00: "Submittal Procedures" for submitting copies of operation and maintenance manuals.
- 2. Section 01 77 00: "Closeout Procedures" for timing of Operation and Maintenance Training for Owner.

1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 SUBMITTALS

- A. Preliminary Submittal: Submit one (1) copy of Operations and Maintenance manual in final form a minimum of two (2) weeks prior to the Project Closeout (Punch List) Meeting. CDOT Representative will return one (1) copy with comments within 10 days of receipt.

- 1. Correct or modify manual to comply with CDOT Representative's comments. Submit two (2) hard copies of corrected manual and two (2) electronic PDF copies on a USB storage drive within 10 days of receipt of Owner or Architect's comments.

1.5 COORDINATION

- A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize the information required in the manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
1. Title page
 2. Table of contents
 3. Manual contents
- B. Title Page: Include the following information:
1. Subject matter included in manual
 2. Name, address, and telephone number of Contractor
- C. Table of Contents: List each product included in the manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
 2. Include Specification Section Number for each product in table of contents
 3. Include the final copy of the Submittal Log
- D. Manual Contents: Organize into sets of manageable size. Arrange contents by specification section number and then alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, (3 inch wide maximum) sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents.
 - a. Identify binder(s) on spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
 2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider.
 3. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
 4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 5. Electronic Copy: Provide a USB storage drive that contains electronic PDFs of all information contained within the Operation and Maintenance Manual. Information to be organized into folders that match the divider section in the hard copy manual.

2.2 OPERATION MANUALS

- A. The Contractor shall refer to Divisions, 22, 23 and 26 specifications concerning the O & M manuals for devices germane to Divisions 22, 23 and 26. Unless otherwise indicated,

organize O & M manuals into 3-ring binders.

1. Copies of Warranties
 2. Index referencing Specification section number
 3. Clear identification of specific product(s) or equipment used
 4. Identification of equipment or products identified in the project manual that may not be typical
 5. Parts list(s)
 6. Start-up procedures
 7. Operating Instructions
 8. Wiring Diagrams
 9. Piped system diagrams
 10. Maintenance instructions
 11. Manufacturer and/or Representative including:
 - a. Name of Firm, Address, Telephone Number, Facsimile Number, Contact Name and e-mail address
 12. List of Contractors, Sub-Contractors
 - a. Name of Firm, Address, Telephone Number, Facsimile Number, Contact Name and e-mail address
- B. Preliminary Submittal: Submit one (1) copy of each manual in final form prior to the Project Closeout (Punch List) Meeting. CDOT Representative will return copy with comments within 10 days of receipt.
1. Correct or modify manual to comply with CDOT Representative's comments. Submit two (2) hard copies of corrected manual and two (2) electronic PDF copies on a USB storage drive within 10 days of receipt of CDOT Representative's comments.
- C. Manuals shall be prepared from the following materials:
1. Loose leaf, punched paper
 2. Dividers with holes reinforced with plastic cloth
 3. Page size, 8-1/2 inches by 11 inches
 4. Foldout diagrams and illustrations
 5. Reproducible by dry-copy xerography method
 6. Oil-, moisture- and wear-resistant plastic covers
- D. General Requirements for Manuals:
1. Manufacturer's operating manuals giving complete instructions relative to assembly, installation operation, adjustment, lubrication, maintenance, cleaning and carrying complete parts list shall be furnished by the Contractor for every item of machinery and equipment furnished by the Contractor.
 2. Manuals furnished may be manufacturer's standard publications in regard to size and binding provided they comply with specified requirements relative to quantity and quality of information and data.
 3. Manuals shall be bound in hard or flexible covers. Illustrations shall be clear, and printed matter, including dimensions and lettering on drawings, shall be easily legible. If reduced drawings are incorporated into manuals, original lines and letters shall be darkened as necessary to retain their legibility after reduction. Larger drawings may be folded into manuals to page size.
- E. Format Manuals as follows:
1. Title page: Include the name and function of the equipment, manufacturer's identification

- number, and the project Specifications number and title.
2. Table of contents, in numerical order listing each section and subsection title of the O&M Manual with reference to the page on which each starts and a list of included diagrams and drawings.
 3. Index, in alphabetical order.
 4. Frontispiece: Recognition illustration of the equipment described in the O&M Manual.
 5. Manufacturer's literature describing each piece of equipment or product, including major assemblies and subassemblies, and giving manufacturer's model number and drawing number.
 6. Operation instructions including step-by-step preparation for starting, safe operation, shutdown and draining, cleaning and emergency requirements.
 7. Control diagrams, as installed by the manufacturer.
 8. Sequence of operation by the control manufacturer.
 9. Wiring diagrams, as installed and color codes, of electrical motor controllers, connections and interlock connections.
 10. Diagrammatic location, function and tag numbers of each valve.
 11. Maintenance instructions: Include step-by-step procedures for inspection, operation checks, cleaning, lubrication, adjustments, repair, overhaul, disassembly, and reassembly of the equipment for proper safe operation of the equipment. Include list of special tools which are required for maintenance with the maintenance information.
 12. Possible breakdowns and repairs.
 13. Manufacturer's parts list of functional components, control diagrams and wiring diagrams, giving manufacturer's model number and manufacturer's part number.
 14. "Long-Lead-Time" spare parts list for spare parts not readily available on the local open market or for which it is anticipated ordering and delivery time will exceed 10 days.
 15. List of nearest local suppliers of all equipment parts.
 16. Lubrication schedule indicating type and frequency of lubrication.
 17. Manufacturer's warranty and guarantee data.
 18. Spare parts data as follows:
 - a. Complete list of parts and supplies, with current unit prices and sources of supply.
 - b. List of parts and supplies that are either normally furnished at no extra cost with purchase of equipment or specified herein to be furnished as part of Contract.
 - c. List of additional items recommended by manufacturer to assure efficient operation for period of 120 days.
 19. Appendix: Include safety precautions, a glossary, and, if available at time of submittal, copies of test reports, and other relevant material not specified to be submitted.
 20. Delete information on material or equipment not used in the work from the O&M Manual.

F. Operating Diagrams:

1. Piping system, electrical wiring diagrams, fuel oil, lubricating oil, water capacity diagrams, and other diagrams, necessary for operation of machinery and equipment shall be furnished and installed where designated by the Engineer.
2. No single diagram shall show more than one system, or parts thereof.
3. Diagrams shall be reproduced by photographic process to a size not to exceed 18 inches by 24 inches and shall be complete and legible in all respects. Systems shall be subdivided into portions which are operable from location where diagrams are installed, and to provide intelligible information within specified size. They shall be made on white paper and vacuum-sealed in transparent plastic material impervious to moisture and oil, and resistant to abrasion. Other formats which are equal in clarity, sharpness, durability and permanence will be considered.

2.3 MAINTENANCE MANUALS

- A. Content: For each system, or piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty information, as described below.
- B. Source Information: List each system, or piece of equipment included in the manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 - 1. Standard printed maintenance instructions, with specific product(s) or equipment identified.
 - 2. Drawings, diagrams, and instructions required for maintenance
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
 - 1. Troubleshooting guide
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service.
- F. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- G. Warranties: Include copies of warranties and lists of circumstances and conditions that would affect validity of warranties.
 - 1. Include procedures to follow and required notifications for warranty claims.
 - a. Facsimile Number, Contact Name and e-mail address

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

- A. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
 - 1. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work.

END OF SECTION

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SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Interior gypsum wallboard
 - 2. Non-load-bearing steel framing
- B. Related Sections include the following:
 - 1. Section 09 51 13: Acoustical Panel Ceilings
 - 2. Section 09 90 00: Painting and Coating

1.3 DEFINITIONS

- A. Gypsum Board Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Refer to Project-Specific "Submittal Log" provided by Owner at Pre-Bid Meeting.

1.5 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Certified Asbestos Free: All gypsum board and joint compounds used in project shall be certified asbestos free.

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 damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Framing and Furring:
 - a. Clark-Dietrich Steel Framing Systems
 - b. Consolidated Systems, Inc.
 - c. Dale Industries, Inc. - Dale/Incor
 - d. MarinoWare; Division of Ware Ind.
 - e. National Gypsum Company
 - f. Scafco Corporation
 - g. Unimast, Inc.
 - 2. Gypsum Board and Related Products:
 - a. American Gypsum Co.
 - b. G-P Gypsum Corp.
 - c. National Gypsum Company
 - d. United States Gypsum Co.

2.2 STEEL PARTITION AND SOFFIT FRAMING

- A. Steel Studs and Runners: ASTM C 645.
 - 1. Minimum Base Metal Thickness: 0.035, / 20 gauge EQ with 50 ksi strength.
 - 2. Depth: 3-5/8 inches unless otherwise indicated on the Drawings.
 - 3. Depth: 2 1/2 inches at perimeter insulated walls and high, insulated curb in administrative area
- B. King Studs at Doors: ASTM C 645
 - 1. Minimum Base Metal Thickness: 0.053 / 16 gauge EQ
 - 2. Depth: 3-5/8 inches unless otherwise indicated on the Drawings.
- C. Deep-Leg Deflection Track: ASTM C 645 top runner with 3 5/8 inch deep flanges for 2 inch minimum vertical slip movement
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width

indicated.

1. Minimum Base Metal Thickness: 0.035 inch / 20 gauge EQ
 2. Minimum Width: 4 inches
- E. Cold-Rolled Channel Bridging: 0.0538-inch bare steel thickness, with minimum 1/2-inch-wide flange.
1. Depth: 1-1/2 inches.
 2. Clip Angle: 1-1/2 by 1-1/2 inch, 0.068-inch- thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base Metal Thickness: 0.035 inch / 20 gauge EQ.
 2. Depth: 7/8 inch.
- G. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.
- H. Cold-Rolled Furring Channels: 0.0538-inch bare steel thickness, with minimum 1/2-inch-wide flange.
1. Depth: 3/4 inch.
 2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare steel thickness of 0.0312 inch.
 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.
- I. Z-Shaped Furring: With slotted or non-slotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.
- J. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.3 INTERIOR GYPSUM WALLBOARD

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Gypsum Wallboard: ASTM C 1396/C 1396/M.
1. 5/8 inch thick, Type X
 2. See Section 06 64 00 Plastic Paneling for detail on interior plywood wainscot.

2.4 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
1. Material: Galvanized or aluminum-coated steel sheet.
 2. Shapes:
 - a. Cornerbead: Use at all outside corners.
 - b. LC-Bead (J-Bead): Use at exposed panel edges and where gypsum board panels abut other materials.

- c. Expansion (Control) Joint: Where indicated or at 20 feet o.c. max in continuous gypsum wall board, vertical application, evenly distributed.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper
 - 2. Tile Backing Panels: As recommended by panel manufacturer
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Fastening Adhesive:
 - 1. Steel: Adhesive recommended for attaching panels to steel framing.
- D. 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 thick.
- E. Isolation Strip at Exterior Walls:
 - 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), non-perforated.
 - 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.

2.7 SURFACE FINISHES

- A. Sand joints and screw holes to provide smooth finish.
 - 1. Texture: Spatter knock-down.

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. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Ceilings: Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.
 - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.3 INSTALLING STEEL FRAMING, GENERAL

- A. Installation Standards: ASTM C 754, and ASTM C 840 requirements 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, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."
- C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.
 - 1. Isolate ceiling assemblies where they abut or are penetrated by building structure.
 - 2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.
 - a. Use deep-leg deflection track where indicated.
- D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

3.4 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.
 - 1. Where studs are installed directly against exterior walls, install foam-gasket isolation strip between studs and wall.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from the plane formed by the faces of adjacent framing.
- C. Extend partition framing 4 inches above highest adjacent ceiling. Brace top of framed wall every 6 feet in two directions to structural supports or substrates above suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating

partitions above ceiling to provide support for gypsum board.

- D. Install steel studs and furring at the following spacing:
 - 1. Single-Layer Construction: 16 inches on center, unless otherwise indicated.
 - 2. Multilayer Construction: 16 inches on center, unless otherwise indicated.
 - 3. At Column Cladding in administrative, 12 inches on center, maximum, or three studs per clad face, minimum.
- E. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.
- F. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. 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.
 - 1. Install two studs at each jamb, unless otherwise indicated.
 - 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint.
 - 3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- G. 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.
- H. Polyethylene Vapor Retarder: Install to comply with requirements specified in Section 07 21 00 "Thermal Insulation".

3.5 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.
- B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.
- C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- E. 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.
- F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- G. Attach gypsum panels to framing provided at openings and cutouts.
- H. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor

- joists and headers. Float gypsum panels over these members using resilient channels, or provide control joints to counteract wood shrinkage.
- I. Form control and expansion joints with space between edges of adjoining gypsum panels.
 - J. Cover both faces of steel stud partition 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. ft. (0.7 sq. m) in area.
 - 2. Fit gypsum panels 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.
 - K. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments and perpendicular walls of dissimilar materials. Provide 1/4 inch wide spaces at these locations, and trim edges with J-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces and perpendicular walls with acoustical sealant.
 - L. Sound Insulated Partitions: Seal construction at perimeters, behind control and expansion 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 manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings. Provide minimum 3 inches, un-faced batt insulation, minimum R-11, for inside wall cavity.
 - M. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
 - 1. Space screws a maximum of 12 inches o.c. for vertical applications.
 - N. Space fasteners in panels that are tile substrates a maximum of 8 inches o.c.

3.6 PANEL APPLICATION METHODS

- A. 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 board. At stairwells and other high walls or where framing is more suitable, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly. Panels may not be installed in both horizontal and vertical directions on the same wall.
- B. Z-Furring Members: Apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints

offset at least one furring member. Locate edge joints of base layer over furring members.

- C. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- D. Multilayer Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.7 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 Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.

3.8 FINISHING GYPSUM BOARD ASSEMBLIES

- 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. Refer to room finish legend on plans for gypsum board finish level.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:
 - 1. Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.
 - 2. Embed tape and apply separate first and fill coats of joint compound to tape, fasteners, and trim flanges.
 - 3. At all exposed areas scheduled to receive paint, provide level 4 finish prior to painting.

3.9 FIELD QUALITY CONTROL

- A. Above-Ceiling Observation: Architect will conduct an above-ceiling observation before installing gypsum board ceilings and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.
 - 1. Notify Architect seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
 - 2. Before notifying Architect, complete the following in areas to receive gypsum board ceilings:
 - a. Installation of 80 percent of lighting fixtures, powered for operation
 - b. Installation, insulation, and leak and pressure testing of water piping systems

- c. Installation of air-duct systems
- d. Installation of air devices
- e. Installation of mechanical system control-air tubing
- f. Installation of ceiling support framing

END OF SECTION

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SECTION 09 51 13
ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this section
- B. Related Sections
 - 1. Section 09 21 16: Gypsum Board Assemblies
 - 2. Section 26 50 00: Lighting

1.2 SUMMARY

- A. This Section includes acoustical panels and exposed suspension systems for acoustical tile ceilings.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each exposed finish unless providing basis of design.
- C. Product test reports
- D. Research/evaluation reports
- E. Maintenance data

1.4 QUALITY ASSURANCE

- A. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory.
- B. Fire-Test-Response Characteristics:
 - 1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 2. Surface-Burning Characteristics: Acoustical panels complying with ASTM E 1264 for Class A materials, when tested per ASTM E 84.
 - a. Smoke-Developed Index: 450 or less.

1.5 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Panels: Full-size panels equal to 5 percent of quantity installed.
 - 2. Suspension System Components: Quantity of each exposed component equal to 5 percent of quantity installed.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANEL CEILINGS, GENERAL

- A. Acoustical Panel Standard: Comply with ASTM E 1264.
 - 1. Recycled Content: Provide acoustical panels with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 25 percent by weight.
- B. Metal Suspension System Standard: Comply with ASTM C 635.
 - 1. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- D. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 1. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.
- E. Seismic perimeter stabilizer bars, seismic struts, and seismic clips.
- F. Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

2.2 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING – ACT-1

- A. Basis-of-Design Product: Match Existing Ceiling Panels. :
- B. Classification: Provide panels complying with ASTM E 1264 for type and form as follows:
 - 1. Type and Form: Type III, mineral base with painted finish; Form 2, water felted
- C. Color: Match Existing

- D. LR: Not less than .80
- E. NRC: Not less than .55, Type E-400 mounting per ASTM E 795.
- F. CAC: Not less than 35.
- G. Edge/Joint Detail: Square Lay-in for 15/16 grid
- H. Thickness: 5/8 inch
- I. Modular Size: 24x48 inch
- J. Fire Performance: Class A

2.3 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING ACT-1

- A. Basis-of-Design Product: Match existing ceiling suspension system.
- B. Double-Web Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges and 7/8 inch x 7/8 inch wall angle.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. End Condition of Cross Runners: Override (stepped) type.
 - 3. Cap Material: Steel or aluminum cold-rolled sheet.
 - 4. Cap Finish: Painted white.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders.
- C. Suspend ceiling hangers from building's structural members, plumb and free from contact with insulation or other objects within ceiling plenum. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers, use trapezes or equivalent devices. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 1. Do not support ceilings directly from permanent metal forms or floor deck; anchor into concrete slabs.
 - 2. Do not attach hangers to steel deck tabs or to steel roof deck.

- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.
- B. Related Sections
 - 1. Division 22, 23, and 26: Painting of Plumbing, Mechanical and Electrical work is specified in Divisions 22, 23 and 26, respectively

1.2 SUMMARY

- A. This Section includes surface preparation and field painting of the following, colors as scheduled:
 - 1. Exposed interior items and surfaces
 - 2. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Paint: Match existing colors. One coat primer on all surfaces and 2 finish coats.
 - 1. Paint exposed surfaces to match existing adjacent surfaces
 - a. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, primed steel structure, concrete building curb, and primed metal surfaces of mechanical and electrical equipment.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
 - 1. Prefinished items include the following factory-finished components:
 - a. Pre-engineered metal building wall panels and trim (Fluoropolymer Finish)
 - b. Finished mechanical and electrical equipment
 - c. Light fixtures
 - d. Conduit (EMT)
 - e. Louvers and Vents (Flouropolymer Finish)
 - 2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
 - a. Foundation spaces
 - b. Furred areas
 - c. Ceiling plenums
 - 3. Finished metal surfaces include the following:
 - a. Anodized aluminum
 - b. Stainless steel
 - c. Chromium plate

- d. Copper
 - e. Bronze and brass
 - f. Galvanized Metal
4. Operating parts include moving parts of operating equipment and the following:
 - a. Valve and damper operators
 - b. Linkages
 - c. Sensing devices
 - d. Motor and fan shafts
 5. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.3 SUBMITTALS

- A. Product Data: For each paint system specified. Include block fillers and primers.
 1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
 3. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).
- B. Samples for Initial Selection: Submit 4 samples of each color and each type of finish – coat material indicated.
- C. Refer to Project-Specific "Submittal Log" provided by Owner at Pre-Construction Meeting.

1.4 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.
- B. Source Limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the 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 a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 - 1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.
 - 2. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F 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.

1.7 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in the paint schedules.
- B. Manufacturer's Names: The following manufacturers are referred to in the paint schedules by use of shortened versions of their names, which are shown in parentheses:
 - 1. Benjamin Moore & Co. (Moore).
 - 2. Deidrich Technologies, Inc. (Diedrich)
 - 3. Diamond Vogel (DV)
 - 4. Devoe Coatings from Akzo Nobel. (Devoe).
 - 5. Glidden Professional and Devoe Coatings from Akzo Nobel (Glidden)
 - 6. Kwal Paint, a division of Sherwin Williams
 - 7. PPG Industries, Inc. (PPG).
 - 8. Pratt & Lambert, Inc. (P & L).
 - 9. Sherwin-Williams Co. (S-W).

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be 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. Colors: Paint to match adjacent existing surface.

2.3 MIXING AND TINTING

- A. Except where specifically noted in this section, all paint shall be ready-mixed and pre-tinted. Agitate all paint prior to and during application to ensure uniform color, gloss, and consistency.
- B. Thinner addition shall not exceed manufacturer's printed recommendations. Do not use kerosene or other organic solvents to thin water-based paints.
- C. Where paint is to be sprayed, thin according to manufacturer's current guidelines.

2.4 INTERIOR PAINT SCHEDULE

- A. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:
 - 1. Semigloss, 100 % Acrylic Latex: 2 finish coats over a primer.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm). Acceptable products include:
 - (1) Moore: Ultra Spec 500 Interior Latex Primer N534
 - (2) DV: DVP Health-Kote Interior Zero VOC Primer
 - (3) Glidden: Lifemaster No VOC Interior Primer 9116-1200.
 - (4) PPG: Speedhide Zero Interior Zero VOC Primer 6-4900.
 - (5) P & L: ProHide Green Interior Latex Primer Z9160/F9160
 - (6) S-W: ProMar 200 Zero VOC Latex Primer B28W2600.
 - b. First and Second Coats: Low Odor, Low VOC 100% Acrylic Interior Latex Semi-Gloss applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm). Acceptable products include:
 - (1) Moore: Ultra Spec 500 Interior Semi-Gloss N539
 - (2) DV: DVP Zero Plus Zero VOC Interior Latex Semi Gloss
 - (3) Glidden: Ultra-Hide No VOC Interior Semi-Gloss Paint 1415-XXXX
 - (4) PPG: Speedhide Zero Interior Zero VOC Latex Semi-Gloss 6-4510.
 - (5) P & L: ProHide Green Interior Semi-Gloss Latex Z9300/F9300 Series
 - (6) S-W: ProMar 200 Latex Zero VOC Semi-Gloss B31-2600 Series.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
 - 1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 - 2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
 - 1. Notify the CDOT Representative about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
 - 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
 - 1. Verify compatibility of primer or coating with paint system. Provide barrier coats over incompatible primers or remove and reprime.
- D. Materials 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 required 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.
- E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the schedules.
 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 3. Provide finish coats that are compatible with primers used.
 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 6. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 7. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
 8. Finish interior of unfinished casework to match exterior.
 9. At the request of CDOT or Architect, provide field test of any high performance coating system.
- 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 the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 2. Omit primer on metal surfaces that have been shop primed and touchup painted.
 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.
- C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.
- D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.
- F. Mechanical items to be painted include, but are not limited to, the following:
1. Exposed piping, pipe hangers, and supports.
 2. Ductwork.
- G. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.
- H. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- I. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

- A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.
1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.
- B. Extra Stock
1. Extra Paint: At the completion of painting, deliver to the Owner any excess paint of each paint color and type used along with the color number or formula for each type.

3.5 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.
- B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

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SECTION 22 00 00
PLUMBING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.
- B. Provide all items, articles, materials, operations, or methods listed, mentioned, or scheduled on drawings and/or herein specified, including all labor, materials, equipment, and incidentals necessary and required for their completion.
- C. Related Sections:
 - 1. Section 22 05 00: Common Work Results for Plumbing
 - 2. Section 22 10 00: Plumbing Piping

1.2 SUBMITTALS

- A. Shop Drawings and Product Data: Submit for the following in accordance with Section 01 33 00.
 - 1. Plumbing Fixtures (Refer to 22 40 00)
 - 2. Water Heater and Accessories
 - 3. Plumbing Specialties (Refer to 22 15 00 and 22 45 00)
 - 4. Drinking Fountain (EWC)
- B. Operating Instructions and Maintenance Data: Submit for the following in accordance with Section 01 78 23.
 - 1. Plumbing Fixtures
 - 2. Water Heater
 - 3. Plumbing Specialties
 - 4. Drinking Fountain (EWC)

1.3 COORDINATION

- A. Refer to project-specific Submittal Log provided at Pre-Bid Meeting.
- B. Contractor to arrange for tap connection to existing city water main. Owner will pay tap fees directly to municipality outside of GC contract. System development fees and similar charges shall be paid by the owner.
- C. Extend water service line into building. Provide curb box, meter, meter pit, valves as required by water department.
- D. Piping shall have adequate anchoring at connection to the main and at all vertical and horizontal bends. Provide concrete thrust blocks as required.
- E. Provide sleeve for water service entry through foundation wall, make entry watertight.

- F. Water service shall be a minimum of 5 feet 0 inches below grade.
- G. Immediately install water service, provide temporary (frost proof) outlet with hose valve outside building for construction purposes.
- H. Building Piping: Provide a complete piping system in building from valve on service to all fixtures and equipment outlets requiring a cold and/or hot water supply. All branch mains and connections to risers shall be valved and drip cocks provided so that entire system may be drained. Provide swing or swivel joints on connections from mains to risers, from risers to branches, with loops, bends, expansion joints, guides, anchors, as required to prevent noise or shock. Provide fixture stops at all hose bibbs, wall hydrants, etc. so that entire system does not need to be shut off when replacing washers.
- I. Damage by Leaks: Plumbing Contractor shall be responsible for damages to the grounds, walks, roads, buildings, piping systems, electrical systems or their equipment and contents caused by leaks in the piping systems being installed or having been installed under this contract. He shall repair at his expense all damage so caused as directed by the Architect. The Owner reserves the right to make emergency repairs as required without voiding the Contractor's guarantee bond, nor relieving the Contractor of his responsibilities during the bonding period.

1.4 CODES, ORDINANCES, PERMITS AND FEES

- A. Execute work per underwriters, public utility, local, state codes, ordinances, and regulations applicable. Contact city water and sewer agencies for verification of all requirements, permits, state fees and inspections prior to submitting bid. Obtain and pay for required permits, inspections, utility service connections, meters and certificates. Systems development fees and similar charges are not to be included in the bid, as they will be paid directly to the utility agency by the Owner upon notification. Notify CDOT Representative of items not meeting said requirements.

1.5 SANITARY DRAINAGE SYSTEM

- A. Obtain permit from agency having jurisdiction, connect to sanitary sewer as shown, provide building sewer, and connect to building drains as shown. System development fees and similar charges, if any, shall be paid by owner.
- B. Provide a complete sanitary system, including all fixtures, traps, vents, waste piping, manholes, rough-ins, and connections as shown or specified.
- C. Manholes: Provide manholes where shown, of the standard type of the governing sewer district, complete with cast iron frames and covers.

1.6 GAS PIPING SYSTEM

- A. Prior to starting work arrange with utility company to provide gas service to and including gas meter prior to starting work. Consult with utility company as to extent of its work, costs, fees, and permits involved. Pay all such costs and fees, and obtain permits.
- B. Provide dielectric fittings and lubricated plug valve on house side of meter.
- C. Provide all gas piping from gas meter to all gas outlets and equipment requiring gas connection. Make all connections to such outlets and equipment and provide a full main size plug valve for

each. Gas pipe sizes 2 inch and smaller may be welded or threaded; 2-1/2 inch and larger to be all welded. All gas piping from underground shall be welded.

PART 2 - PRODUCTS

2.1 GAS VALVES

- A. Valves, NPS 2 inch and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
- B. Valves, NPS 2-1/2 inch and Larger: Flanged ends according to ASME B16.5 for steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
- C. Gas Valves, NPS 2 inch and Smaller: ASME B16.33 and IAS-listed bronze body and 125-psig pressure rating.
 - 1. Tamperproof Feature: Include design for locking.
- D. Gas Stops (at appliance only): Bronze body with AGA stamp, plug type with bronze plug and flat or square head, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 2-psig minimum pressure rating.
- E. Plug Valves, NPS 2-1/2 inch and Larger: ASME B16.38 and MSS SP-78 cast-iron, lubricated plug valves, with 125-psig pressure rating.
 - 1. Tamperproof Feature: Include design for locking.

2.2 WATER PRESSURE REDUCING VALVE

- A. Furnish and install a one or two stage pressure reducing station as required on cold water supply main in the event that water is supplied from water company source at a pressure in excess of 75 psi. Reducing station to be located at service entry where shown or directed. Basic requirements are as follows:
- B. Reducing Valve: Conbraco, Fisher Co., Mueller Co., single seated regulation valve having a full line size capacity to reduce from main pressure to 45 psig, pressure drop across valve not to exceed 10 psi when valve is wide open.
- C. Provide a strainer and a three valve by-pass with a ball valve in the by-pass line and a Josam No. 75000 shock absorber on the low pressure side.
- D. Install pressure gauge with cocks on both high and low pressure sides of the regulator.

2.3 REDUCED PRESSURE BACKFLOW PREVENTER

- A. Approved Manufacturers: Conbraco, Febco, Watts, Wilkins.
- B. Provide full line size reduced pressure backflow preventer as shown on plans and detail.

- C. Backflow preventer shall consist of two independently operating, spring loaded "Y" pattern check valves and one hydraulically dependent differential relief valve. The device shall automatically maintain a 5 psi pressure difference in the "zone" between the check valves. Valve body and caps shall be bronze. Check valve and relief valve components shall be constructed so they may be serviced without moving the valve body from the line. Shutoff valves and test cocks shall be rated to a minimum 175 psi water working pressure and water temperature range from 32°F to 180°F. The device shall meet the requirements of ASSE Standard 1013; AWWA Standard Code C506-78; and VSC foundation for cross connection control and Hydraulic Research, Sixth Edition.

2.4 WATER METER

- A. Approved Manufacturers: Badger, Census, Hersey Co., Neptune.
- B. Displacement or compound type, to meet all requirements of water department.

2.5 CURB VALVE AND CURB BOX

- A. For cast iron water pipe, IBBM solid wedge gate, 200 psi working pressure, bell or mechanical joints ends, AWWA specifications, non-rising stem.
- B. For copper water service, 1-1/2 inch and smaller, all bronze curb stop cock with combined cap and tee.
- C. Access to curb valve to be cast iron, tar coated, adjustable valve box with flanged bell, cover marked "water", set flush with sidewalk level. Furnish one extension key to fit valve, length as required.

2.6 HYDRANTS AND SHOCK ABSORBERS

- A. Approved Manufacturers: Josam, J.R. Smith, Woodford Co., Zurn.
 - 1. Wall Hydrants (Freeze proof Box Type): Woodford No. B-67 cast bronze non-freeze box type, polished face, hinged locking cover, brass wall casing, nylon seat, brass operating parts, vacuum breaker.
 - 2. Hose Bibbs (Equipment Rooms and Unfinished Areas): Chicago Faucet Co., No. 952, inside sill faucet with vacuum breaker, 3/4 inch threaded hose outlet, removable tee handle.
 - 3. Shock Absorbers: Zurn Shoktrol Series Z-1700 stainless steel shell, stainless steel bellows pressurized pneumatic cushion. Install where required to prevent shock or water hammer in the piping systems.

2.7 THERMOMETERS

- A. Approved manufacturers are Marsh, Moeller, Taylor, Trerice, U.S. Gage, and Weiss. Mercury industrial type 7 inch scale, 30°F to 200°F red reading, inclined form brass case, separable socket. Mount where easily readable from the floor.

2.8 PRESSURE GAUGES

- A. Approved manufacturers are Ashcroft, March, Lonergan, Taylor, Trerice, U.S. Gage and Weiss. 4-1/2 inch size, cast aluminum case, phosphor bronze bourdon tube, monel rotary movement, nylon gears, silver soldered joints with gauge cock and impulse dampener. Average operating pressure shall fall approximately in the middle of the scale selected.

2.9 PRESSURE AND TEMPERATURE GAUGE TEST PLUGS

- A. Approved manufacturer is Peterson Equipment Co., Peterson plug #710. Test plug and cap to be provided where thermometers and pressure gauges are shown on Drawings. Provide two pressure gauge adapters and two testing thermometers, 1/2 inch NPT, Nordel or EPDM core. Approved equals: Sisco BNO-500, Hydro-Temp, MGP/T, deliver to Owner's representative.

2.10 TEMPERATURE-PRESSURE RELIEF VALVES

- A. Approved manufacturers are McDonnel, Miller and Watts. Self-closing, all bronze, set at 100 psi, 210°F ASME approved. Provide copper drain pipe, full size of outlet, extend to floor drain.

2.11 DRAINAGE SPECIALTIES

- A. Approved Manufacturers: Josam, J.R. Smith, Zurn and ACO or CDOT-approved-equals. See Architectural and Mechanical Plans for Locations.

1. 4-inch Floor Drains Zurn Z415 Body Assembly with "Type B" Strainer
2. Trench Drain Zurn Z812-BDC 12 inch Fiberglass Flo-Thru Trench Drain
Epoxy Coated Ductile Grate Class C
Alternate: ACO Polymer Concrete S300K
3. Catch Basin Zurn Z817-24-DGC-Y Flo Thru Basin with Removable Ductile
Iron Class C grate and Sediment Bucket
Alternate: ACO 2x2 Polymer Concrete Catch Basin 05719 w/
Grey Iron Frame, and removable slot grate 05720
4. Catch Basin Strainer Provide stainless steel mesh strainer and stainless steel lift out
basket

2.12 CLEANOUTS

- A. Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1, countersunk head.
- B. Floor Cleanouts: Cast-iron body and frame; cleanout plug; adjustable round top as follows:
 1. Nickel-Bronze Top: Manufacturers standard cast unit of the pattern indicated:
 - a. Pattern: Exposed rim type, with recess to receive 1/8 inch thick resilient floor finish.
 - b. Pattern: Exposed rim type, with recess to receive 1 inch thick terrazzo floor finish.

- c. Pattern: Exposed finish type, standard mill finish.
 - d. Pattern: Exposed flush type, standard non-slip scored or abrasive finish.
- C. Grade Cleanouts: Cast-iron body and frame; cleanout plug; adjustable round top as follows:
 - 1. Cast-iron Top: Manufacturers standard cast unit of the pattern indicated:
 - a. Pattern: Exposed flush type, standard mill finish.
 - b. Pattern: Exposed flush type, standard non-slip scored or abrasive finish
- D. Wall Cleanouts: Cast-iron body adaptable to pipe with cast-bronze or brass cleanout plug; stainless steel cover including screws.

2.13 VENTS THROUGH ROOF

- A. Provide all vents with vandal-proof caps, cast iron, with vandal-proof hood and set screws, Josam Series 26700 or equal by Stoneman Co.

2.14 DOMESTIC WATER HEATERS (GAS)

- A. Approved Manufacturers: A.O. Smith, Bradford White, Lochinvar, Rheem, Ruud and Inc, and State.
- B. Heaters to be gas-fired, direct-vent, tank type with three year Limited parts warranty, built-in electronic blower, digital display showing temperature settings and maintenance codes, vents horizontally or vertically. Provide 100 gallon capacity, 125 psi working pressure, ASME rated temperature and pressure relief valve with full size drain piped to floor. Provide with hot water recirculation pump, piping and valves. Refer to schedules on plans for model and capacity.
- C. Provide full size ball valve in cold and hot water inlet line to heater.
- D. Provide dielectric unions at heater inlet connections.

2.15 FIXTURES

- A. Approved Manufacturers: See Section 22 40 00, 2.1 "Plumbing Fixtures".
- B. Fixtures shall be delivered to the job and the CDOT Representative notified in sufficient time so that inspection before installation may be made without delaying the progress of the work. The Contractor is fully responsible for protection of fixtures before and after inspection until final acceptance of the entire building by the Owner. All damaged fixtures shall be immediately replaced by this Contractor regardless of who caused the damage. All exposed brass pipe shall be chrome plated.
- C. Fixture List: Refer to fixture list on drawings.

PART 3 - EXECUTION

3.1 SIZE OF FIXTURE CONNECTIONS

- A. Branch connections to fixtures shall be as follows, unless shown otherwise:

Water closets, flush valve	1 inch	CW
Water closets, tank type	1/2 inch	CW
Sinks, service sinks	1/2 inch	H & CW
Lavatories	1/2 inch	H & CW
Urinals	1/2 inch	CW
Drinking fountains & electric water coolers	1/2 inch	CW
Showers	1/2 inch	H & CW
Sinks	1/2 inch	H & CW

3.2 EXAMINATION

- A. Examine roughing-in for water and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.
1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-hanging fixtures with tubular waste piping attached to supports.
- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball or globe valve if stops are not specified with fixture.
- I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- J. Install toilet seats on water closets.
- K. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- L. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- M. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- N. Install traps on fixture outlets.
 1. Exception: Omit trap on fixtures with integral traps.
 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- O. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Section 22 05 00 "Common Work Results for Plumbing" for escutcheons.
- P. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Section 07 92 00 "Joint Sealants" for sealant and installation requirements.

3.4 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.
- F. Ground equipment.
 1. 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.

3.5 SHOCK ABSORBERS

- A. Provide shock absorbers on all water lines servicing quick closing valves, such as flush valve water closets, urinals, clothes washers and dishwashers. Install per manufacturer's recommendations.

3.6 SANITARY DRAINAGE SYSTEM

- A. Contractor to verify size, location and elevation of existing sanitary sewers before starting work.
- B. Line and Grades: Lay piping true to line and grade so that sewer will have smooth and uniform invert throughout its length. Grade piping by measuring with rod from overhead grade line set horizontal and set taut between grade bars to prevent sagging. Contractor to verify elevations of existing sewers before starting work. Unless otherwise indicated or directed, maintain 30 inch minimum cover above piping. All drainage piping inside of building shall have a uniform grade of not less than 1/4 inch per foot in direction of flow as required by local building department, unless otherwise noted.
- C. Flashings:
 - 1. Vents through roof shall terminate 12 inches above roof. Secure vents to roof to protect from snow load or snow dump.
 - 2. Flash vents and roof drains with 4 lb. lead, extend vent flashing around pipe and over top 2 inches, beat down in pipe 1 inch.
 - 3. The base of the flashings shall be minimum 12 inches x 12 inches on the roof for 2 inch and 3 inch vents; 18 inches x 18 inches for 4 inch vents; 24 inches x 24 inches for 6 inch vents, 30 inches x 30 inches for roof drains.
 - 4. For each floor drain above grade, provide 24 inches square 4 lb. sheet lead flashing clamped or soldered into flashing ring of drain.

3.7 GAS PIPING SYSTEM

- A. Gas piping shall be installed in strict accord with NFPA Pamphlet No. 54.
- B. All gas piping run outside and above grade shall be finished with a corrosion resistant enamel paint, black color or color as directed by architect to match building color.
- C. All underground gas piping outside of building shall be machine wrapped with "Scotchrap" PVC tape using 50% overlap wrap minimum. Fittings and all joints shall be double wrapped, and fitting wrapping shall extend not less than 6 inches past the end of the fittings onto the pipe section. All testing of pipe and fittings shall be done prior to wrapping the fittings. Pipe may be wrapped prior to testing.
- D. All steel and iron pipe shall be coated with "Scotchrap" primer before wrapping.

- E. All pipe wrapping shall conform to the following schedule:

<u>Pipe Size</u>	<u>Tape Width</u>	<u>Scotchrap No.</u>	
		<u>10 Mil</u>	<u>20 Mil</u>
1/4" - 3/4"	1"	50	51
1" - 1-1/2"	2" or 4"	50	51
2" and larger	4"	50	51
Color Backing		Black	Black

Note: During application of wrap, if the ambient temperature is 40° or less, use only "Scotchrap" No. 40 tape. If ambient temperature is 41°F or more, use only "Scotchrap" No. 50.

- F. Gas piping under floor slabs, inside of building, shall not be used.
- G. ASTM-A-106 welding fittings shall be used on all gas piping 2-1/2 inches and larger.

3.8 TESTS FOR PLUMBING AND DRAINAGE SYSTEMS

- A. Test all plumbing work as specified below and according to local code regulations. See "Schedule of Testing" in "General Mechanical Requirements" of the specifications.
- B. Sectionalizing: Piping may be tested a section at a time in order to facilitate the construction.
- C. All hot and cold water lines shall be capped or plugged and tested with 100 lb. hydrostatic test, and proved tight before all piping is covered or concealed in any part of the building construction. Fill the section of pipe to be tested with water and bring the section up to pressure with a test pump. Tests shall be conducted by the Mechanical Contractor in the presence of the General Contractor. These tests shall be conducted before any insulation is installed, and all insulation installed prior to these tests shall be removed. Gauges in the tests shall have been recently calibrated with a dead weight tester. All tests shall apply full test pressure to the piping for a minimum of 24 hours.
- D. Inability to Hold Pressure: When test pressure has fallen over 5% during the 24 hour test period, the point of leakage shall be found, repaired, and the test repeated. This procedure shall be followed until the piping system has been proven absolutely tight.
- E. All soil, waste, and vent piping within the building shall be tested to a 10 feet hydrostatic test, and all joints inspected while under pressure.
- F. All soil, waste, and vent piping outside the building shall be tested to a minimum 10 feet of pressure head. Each joint shall be watertight after 15 minutes.
- G. All gas piping shall be tested under, and proven tight, at an air pressure of 100 lbs. per square inch gauge for a period of 2 hours. All gas pipe testing shall be performed in the presence of a representative of the Mechanical Engineer or Owner.
- H. All piping shall be tested and proved to be tight before being concealed in the building construction.
- I. Before final acceptance of the system as a whole, this Contractor shall make all adjustments as required and place the entire plumbing system in perfect operating condition.

3.9 STOP VALVES

- A. All fixtures, wall hydrants, yard hydrants, hose bibs, rough-ins, etc., to be supplied with stop valve to prevent shutting down entire water system when replacing faucet washers.

3.10 VACUUM BREAKERS

- A. Provide line size vacuum breaker on all branch lines to all outlets with threaded outlets where a hose may be attached.

3.11 WATER SUPPLY SYSTEM

- A. Clean and disinfect potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
 - 2. Use purging and disinfecting procedures as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- E. Install fresh batteries in sensor-operated mechanisms.

3.13 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

- B. Operate and adjust disposers, water dispensers, and controls. Replace damaged and malfunctioning units and controls.
- C. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.

3.14 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 2. Remove sediment and debris from drains.

3.15 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

3.16 PLUMBING SPECIALTIES INSTALLATION

- A. Refer to Section 22 05 00 "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
 1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 2. Do not install bypass piping around backflow preventers.
- B. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.
- C. Install strainers on supply side of each pressure regulator.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install Y-Pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve and pump.
- F. Install water hammer arrestors in water piping according to PDI-HW 201.
- G. Install supply type trap seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- H. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4 inch Use NPS 4 inch for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 inches and smaller and 100 feet (30 m) for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- I. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
- J. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
- K. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.
- L. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.
- M. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
- N. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- O. Install interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
1. Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
 2. Coordinate oil-interceptor storage tank and gravity drain with Section 22 32 00 Recycled Water System.

- P. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.
- Q. Fasten recessed-type plumbing specialties to reinforcement built into walls.
- R. Install wood-blocking reinforcement for wall-mounting and recessed-type plumbing specialties.
- S. Install individual shutoff valve in each water supply to plumbing specialties. Use ball or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to Section 22 05 00 Subsection "Valves" for general-duty ball, butterfly, check, and globe valves.
- T. Install air vents at piping high points. Include ball or globe valve in inlet and drain piping from outlet to floor drain.
- U. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- V. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.
- W. Plumbing Specialty Connections
 1. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 2. Install piping adjacent to equipment to allow service and maintenance.
 3. Connect plumbing specialties to piping specified in other Division 22 Sections.
 4. Ground equipment.
 5. 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.
 6. Connect plumbing specialties and devices that require power according to Division 26 Sections.
 7. Interceptor Connections: Connect piping, flow-control fittings, and accessories.
 - a. Oil Interceptors: Connect inlet, outlet, vent, and gravity draw off piping to unit; flow-control fitting and vent to unit inlet piping; and gravity draw off and suction piping to oil storage tank.

3.17 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 1. Lead Sheets: Burn joints of lead sheets 6-lb/sq. ft, 0.0938-inch thickness or thicker. Solder joints of lead sheets 4-lb/sq. ft., 0.0625-inch thickness or thinner.
 2. Copper Sheets: Solder joints of copper sheets.

- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.18 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section
- B. Work Included in This Section:
 - 1. Pipe Hangers and supports
 - 2. Sleeves
 - 3. Dielectric Fittings
 - 4. Plates and Escutcheons
 - 5. Flashings and Seals
 - 6. Expansion Compensation
 - 7. Valves
 - 8. Dielectric Connections
 - 9. Copper Water Piping Joints
 - 10. Welding
 - 11. Access Doors
 - 12. Freeze Protection Systems for Piping and Equipment
 - 13. Excavating for Plumbing Work
 - 14. Backfilling
 - 15. Cutting and Patching
 - 16. Concrete Bases
 - 17. Drip Pans
 - 18. Piping Installation
 - 19. Tests
 - 20. Identification Materials for Piping and Equipment
- C. Related Sections
 - 1. Section 08 31 13: Access Doors and Frames
 - 2. Division 22 and 23 Sections

1.2 QUALITY ASSURANCE

- A. Welder Qualifications: Welders shall be certified by the National Certified Pipe Welding Bureau (NCPWB) for the type of work being performed. Operators' certificates shall be on file at the site and shall be available to the Structural Engineer for examination.

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards:
 - 1. Canadian Gas Association (CGA)
 - 2. American Water Works Association (AWWA)
 - 3. ANSI B31 Code for Pressure Piping
 - 4. National Certified Pipe Welding Bureau (NCPWB)

5. National Fire Protection Association (NFPA)
6. Underwriters Laboratories (UL)

1.4 SUBMITTALS

- A. Shop Drawings and Product Data: Submit for the following in accordance with Section 01 33 00 and 22 00 00.
 1. Valves
 2. Pipe Hangers and Supports
- B. Operating Instructions and Maintenance Data: Submit for the following in accordance with section 01 78 23 and 22 00 00.
 1. Valves

PART 2 - PRODUCTS

2.1 PIPE HANGERS, INSERTS AND SUPPORTS

- A. General:
 1. Study thoroughly all architectural, structural, mechanical, and electrical drawings, shop drawings, and catalog data to determine how piping systems are to be supported, mounted, or suspended. Provide extra steel bolts, inserts, pipe stands, steel angles, brackets and accessories for proper support whether or not shown on drawings.
 2. All work installed under Division 22 shall be supported plumb, rigid, and true to line.
 3. Adjustable pipe hangers shall be used on suspended pipe. Hangers shall be vertically adjustable minimum (+/-) 1-1/2 inches after piping is erected.
 4. Chain or perforated strap hangers will not be permitted.
 5. Water Supply piping, where practical, shall be placed at the same elevation and suspended with trapeze type hangers.
 6. Provide copper plated hangers and supports for copper piping or tubing.
 7. Isolate hangers of dissimilar metals from coming in contact with bare piping with plastic sheet lead or other suitable dielectric material securely held between hanger and pipe.
 8. Hangers and supports shall impede disengagement by movement of supported pipe.
 9. Provide stainless steel hangers and supports at Wash Bays.
- B. Each Contractor shall be responsible for all drilling required for the installation of his hangers.
- C. Concrete Inserts: Galvanized malleable iron shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods and lugs for attaching to forms or machine bolt expansion anchors. Size inserts to match size of threaded hanger rods.
- D. Hanger Rods: Continuous threaded steel, sizes as specified in table below.

1. Hangers:
 - a. Hot Pipes:
 - 1) ½ inch through 1-1/2 inch: Adjustable Wrought Steel Ring
 - b. Cold Pipes:
 - 1) ½ inch through 1-1/2 inch: Adjustable Wrought Steel Ring

E. Hanger Sizes and Spacing: Provide hangers with maximum spacing and hanger rods with minimum sizes as follows:

<u>Pipe Type</u>	<u>Pipe Size</u>	<u>Maximum Spacing</u>	<u>Minimum Hanger Rod Size</u>
Steel Pipe	1/2" and under	6'-0"	3/8"
	3/4" through 1-1/4"	8'-0"	3/8"
	1-1/2" and 2"	10'-0"	3/8"
Copper Pipe	1-1/2" and smaller	6'-0"	3/8"
	2" and larger	8'-0"	3/8"
Plastic Pipe	1-1/2" and under	4'-0"	3/8"
	2" and above	4'-0"	1/2"
Cast Iron	2"	See Below	3/8"
	3"	See Below	1/2"
	4" and 5"	See Below	5/8"

- F. Cast Iron Soil Pipe: Support within 1 foot of every hub, maximum 5 foot intervals.
- G. Buried Piping: Shall be laid on firm bed free of rocks and debris for its entire length.
- H. No Hub Cast Iron: Support within 1 foot of each side of couplings for piping lengths feet or longer; one hanger at each coupling for piping lengths less than 4 feet; one hanger at each fitting.
- I. Insulated Piping Supports: All insulated piping shall have insulation continuous through hangers, and shall be protected at points of support with thermal hanger shields. Thermal hanger shields shall consist of a 360° insert of high density, waterproofed calcium silicate, encased in a 360° sheet metal shield. Insert shall be same size of adjoining pipe insulation. See table below for shield length and minimum sheet metal gauge. Calcium silicate insert shall extend minimum one inch beyond sheet metal shield. If pipe hanger spacing exceeds 10 feet, utilize double layer of sheet metal, gauge as shown below, on all bearing surfaces.

<u>Pipe Size</u>	<u>Shield Length</u>	<u>Minimum Gauge</u>
1/2" through 1-1/2"	4"	26
2" through 6"	6"	20

- J. Vertical Piping Support:
 1. Provide friction riser clamps, supported and braced.
 2. Isolate supports of dissimilar metals from coming in contact with bare piping with plastic sheet or other suitable dielectric material securely held between support and pipe.

3. Provide vertical piping support with maximum spacing as follows:

<u>Pipe Type</u>	<u>Pipe Size</u>	<u>Maximum Spacing</u>
Steel Pipe	1-1/2" and under	8'-0"
	2" and over	10'-0"
Copper Pipe	1-1/2" and under	6'-0"
	2" and over	8'-0"

- K. Cast Iron Soil Pipe: Minimum one support per story height and at its base. Where practical, support vertical riser piping independently of connected horizontal piping.
- L. Plastic Pipe: Minimum one (1) support per story height and at its base. Provide intermediate pipe guides at mid-story. Compensate for expansion at minimum 30 foot intervals.
- M. Floor support for pipe sizes to 4 Inches and all cold water pipe sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier or steel support. ANSI/MSS-SP-69 Type 38.
- N. Acceptable Manufacturers: B-Line, Elcen, Fee and Mason, Grinnell, Michigan Inc., PHD Manufacturing, Superstrut, Unistrut.

2.2 SLEEVES

- A. Sleeves shall be constructed of 24 gauge galvanized sheet steel with lock seam joints for all sleeves set in concrete floor slabs terminating flush with the floor. All other sleeves shall be constructed of galvanized steel pipe unless otherwise indicated on the drawings. "Crete Sleeve" plastic type sleeves are acceptable for concrete construction, as manufactured by Sperzel Division, Shamrock Industries.
- B. Provide all cutting, patching of holes, opening, notches. Obtain written approval before notching, boring, chipping, burning, drilling, and welding to structural members.
- C. This subcontractor shall provide and locate all sleeves and inserts required before the floors and walls are built, or shall be responsible for the cost of cutting and patching required for pipes where sleeves and inserts were not installed, or where incorrectly located.
- D. Sleeves shall be provided for all piping passing through concrete floor slabs and concrete, masonry, tile, and gypsum wall construction.
- E. Terminate sleeves flush with walls, partitions and ceiling.
- F. In areas where pipes are concealed, as in chases, terminate sleeves flush with floor.
- G. In all areas where pipes are exposed, extend sleeves ¼ inch above finished floor, except in rooms having floor drains, where sleeves shall be extended 1 inch above floor.
- H. Fasten sleeves securely in floors, walls, so that they will not become displaced when concrete is poured or when other construction is built around them. Take precautions to prevent concrete, plaster, or other materials getting forced into the space between pipe and sleeve during construction.
- I. Sleeve Sizing:

1. Where pipe motion due to expansion and contraction will occur, make sleeves of sufficient diameter to permit free movement of pipe.
2. Oversized sleeves shall be provided where pipes penetrate exterior walls below grade to prevent breakage.
3. Insulated Piping Requiring Vapor Barrier: Insulated piping which shall normally or periodically be subject to operating temperatures less than the surrounding dew point shall have sleeves which are large enough to pass both piping and the continuous insulation, and shall allow free movement of pipe and insulation.
4. Insulated Piping Not Requiring Vapor Barrier: Insulated piping which shall normally be subject to operating temperatures above the surrounding dew point shall have sleeves large enough to pass the piping only, allowing for free movement of pipe. Insulation shall be made to butt up on both sides of sleeve.

2.3 PLATES AND ESCUTCHEONS

- A. Provide tight fitting cover plates on cleanout openings in walls, ceilings, and floors, chrome plated in finished areas, galvanized cast iron in unfinished areas and mechanical rooms.
- B. Provide one piece type escutcheons on pipes passing through walls, floors and ceilings. Escutcheons shall be chrome plated brass or chrome plated steel, one piece type with set screw for fastening to pipes or sleeve in finished areas. Escutcheons shall be galvanized cast iron in unfinished areas and mechanical rooms. Coordinate piping with flat part of all metal wall panels whenever possible. Holes for penetrations are not to exceed 1/4 inch larger than the pipe.

1. Size: Use escutcheons that fit tight around pipes and insulation, cover openings around pipes, and cover the entire pipe sleeve projection. Where pipe sleeve projects from wall further than permissible with one piece type escutcheon, provide telescoping two piece type escutcheon of size sufficient to cover wall opening, pipe and pipe sleeve.
2. Minimum thickness:
 - a. Floor escutcheons: 0.094 inches (3/32 inch)
 - b. Wall and ceiling escutcheons:

<u>Pipe Size</u>	<u>Thickness</u>
2-1/2" and under	0.025"
3" and over	0.035"

2.4 FLASHING AND SEALS

- A. Steel Flashing: 26 gauge galvanized sheet metal, to match roof contour.
- B. Flexible Neoprene Pipe Flashing: One piece, cone shaped, seamless, molded, 0.060 inch thick uncured neoprene, water absorption maximum one percent (1%) by weight, tensile strength minimum 1800 psi, elasticity minimum three hundred percent (300%) with full recovery without set, match color of surrounding roofing.

- C. Sleeve Seal in Exterior Wall Below Grade: Pack annular space between pipe or conduit and sleeve with oakum and lead and make completely watertight.
- D. Modular Mechanical Type Waterproof Seal: Interlocking synthetic rubber links, sized to fill annulus between pipe or conduit and wall opening. Rubber links expanded to form watertight seal with zinc coated bolts.
- E. Fire Barrier Sealant: Firestop type putty such as "Flameseal" manufactured by Nelson Co. shall be packed within annular space surrounding pipe or duct by Mechanical Contractors on both sides of wall or floor. UL classified as "Wall Opening Protective Device," non-toxic, non-allergenic before and after cure. Material must meet requirements of NEC (NFPA), Article 300-21. Material must seal watertight, be of sufficient viscosity to withstand direct fire hose impact, less than flame spread 25, fuel contributed 25, and ASTM E 814 shall not be exceeded. Other acceptable manufacturers are 3M (Fire Barrier), IPC (Flamesafe) and Dow Corning (System 2000). Fire barrier sealant shall meet requirements of UL Standard 1479.

2.5 EXPANSION COMPENSATION

A. Flexible Connections:

- 1. 3/4 inch through 1-1/2 inch: Wire and fabric reinforced flexible duty hose rated for 150 psi at 240° F. Fittings shall be brass screw type attached by expansion or swedging method. Overall lengths shall not exceed the following: 9 inches for 3/4 inch; 10 inches for 1 inch; 13 inches for 1-1/2 inches; 15 inches for 1-1/2 inches; hoses shall be Mason Industries Type RMM.

2.6 VALVES

A. General:

- 1. Provide valves where necessary for isolation of equipment and for proper operation and maintenance. Locate valves for easy access and operation. When installed in concealed location, provide access panels to insure required maintenance accessibility to all valves.
- 2. All valves of a given type shall be of one manufacturer and shall be listed with the Manufacturers Standardization Society of the Valve and Fittings Industry.
- 3. Ball valves, butterfly valves or eccentric valves shall be used in lieu of gate valves wherever the pressure and temperature ratings are satisfactory for the intended service.

B. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.

C. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, 6 inches and smaller, other than plug valves. Provide one wrench for every 10 plug valves. Provide chain-operated sheaves and chains for overhead valves as indicated.

1. GLOBE VALVES

a. Comply with the following standards:

- 1) Cast-Iron Valves: MSS SP-85
- 2) Bronze Valves: MSS SP-80
- 3) Steel Valves: ANSI B16.34

- b. Acceptable Manufacturers
 - 1) Crane Co.
 - 2) Hammond Valve Corp.
 - 3) Jenkins Bros.
 - 4) Milwaukee Valve Co., Inc.
 - 5) Nibco, Inc.
 - 6) Powell (Wm.) Co.
 - 7) Stockham Valves
 - 8) Walworth Co.

2. DRAIN VALVES

- a. Comply with the following standards:
 - 1) Water Heater Drain Valves: ASSE 1005
- b. Acceptable Manufacturers:
 - 1) Conbraco
 - 2) Hammond Valve Corp.
 - 3) Nibco Inc.
 - 4) Prier Brass Mfg. Co.
 - 5) Red-White

3. PLUG VALVES

- a. Acceptable Manufacturers:
 - 1) Powell (The Wm.) Co.
 - 2) Rockwell International; Flow Control Div. (Nordstrom)
 - 3) Walworth Co.

4. BALL VALVES

- a. Comply with the following standards:
 - 1) Cast-Iron Valves: MSS SP-72
 - 2) Steel Valves: ANSI B16.34
 - 3) Bronze Valves: MSS SP-80
- b. Acceptable Manufacturers:
 - 1) Apollo
 - 2) Hammond Valve Corp.
 - 3) Jamesbury Corp.
 - 4) Jenkins Bros.
 - 5) Jomar International
 - 6) Nibco, Inc.
 - 7) Powell (The Wm.) Co.
 - 8) Stockham Valves and Fittings, Inc.
 - 9) Walworth Co.

D. VALVE FEATURES

1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by Installer for installation requirements. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
2. Bypass: Comply with MSS SP-45, and except as otherwise indicated, provide manufacturer's standard bypass piping and valving.
3. Drain: Comply with MSS SP-45, and provide threaded pipe plugs.
4. Flanged: Valve flanges complying with ANSI B16.1 (cast iron), ANSI B16.5. (steel), or ANSI B16.24 (bronze).
5. Threaded: Valve ends complying with ANSI B2.1.
6. Butt-Welding: Valve ends complying with ANSI B16.25.
7. Socket-Welding: Valve ends complying with ANSI B16.11.
8. Solder-Joint: Valve ends complying with ANSI B16.18.
9. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron, ANSI B16.5 (steel), or ANSI B16.24 (bronze).
10. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections:
11. Tube Size 2 inch and Smaller: Soldered-joint valves.
12. Pipe Size 2 inch and Smaller: One of the following, at Installer's option:
 - a. Threaded valves
 - b. Grooved-end valves
 - c. Butt-welding valves
 - d. Socket-welding valves
 - e. Flanged valves
 - f. Flangeless valves
 - g. Single flanged valves
13. Valve Stem: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of OS&Y valves.
14. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.
15. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.
16. Fluid Control: Except as otherwise indicated, install ball valves to comply with ANSI B31.9. Where throttling is indicated or recognized as principal reason for valve, install globe or butterfly valves.

E. Provide the following valves for various valve types listed in Division 22 piping sections.

1. GLOBE VALVES

- a. 2 inch and Smaller: Class 125, bronze body, screw-in bonnet, integral seat, renewable disc.

	<u>Threaded</u> <u>Ends</u>	<u>Solder</u> <u>Ends</u>
Nibco:	T-235	S-235

- b. 2 inch and Smaller: Class 125, bronze angle body, screw-in bonnet, integral seat, renewable disc.

	<u>Threaded</u> <u>Ends</u>	<u>Solder</u> <u>Ends</u>
Nibco:	T-311	S-311

2. DRAIN VALVES

- a. Class 125: Bronze body, screw-in bonnet, rising stem, composition disc, 3/4 inch hose outlet.

	<u>Threaded</u> <u>Ends</u>	<u>Solder</u> <u>Ends</u>
Nibco:	73	72

3. PLUG VALVES

- a. 2 inch and Smaller: 150 psi, bronze body, straightaway pattern, square head, threaded ends.

1) Homestead: 611

- b. 2-1/2 inch and Larger: 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.

- 1) Nordstrom: 143
2) Powell: 2201
3) Walworth: 1718F

4. BALL VALVES

- a. 1 inch and Smaller: 150 psi, bronze body, full port, bronze trim, 2-piece construction, TFE seats and seals.

	<u>Threaded</u> <u>Ends</u>	<u>Solder</u> <u>Ends</u>
Nibco:	T-585	S-585

- b. 1-1/4 inch to 2 inches: 150 psi, bronze body, full port, 3-piece body, TFE seats with bronze trim.

	<u>Threaded</u> <u>Ends</u>	<u>Solder</u> <u>Ends</u>
Apollo:	82-100	82-200
Nibco:	T-595-Y	S-959-Y
Powell:	4201-R	4201-R
Watts:	B-6800	B-6801

- c. Hose End: 3/4 inch Apollo 78-100 or 78-200 (or equal). bronze body, chrome plated 2 piece construction, TFE seats & seals, 3/4 inch hose outlet with dust cap.

2.7 ACCESS TO PLUMBING

- A. Access Units Fire-Resistance Ratings: Where fire-resistance rating is indicated for construction penetrated by access units, provide UL listed-and-labeled units, except for units which are smaller than minimum size requiring ratings as recognized by governing authority.
- B. Provide access doors required for access to plumbing, whether shown or not.
- C. Access Doors: Where floors, walls and ceilings must be penetrated for access to plumbing, furnish types of access doors indicated, including floor doors if any. Furnish adequate size for intended and necessary access. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware. Access doors to comply with Section 08 31 13- Access Doors and Frames.
- D. Where valves, control devices, cleanouts and similar plumbing elements are located within or behind wall, ceiling or floor construction or finishes, or below grade, and are not (cannot be) provided with integral removable access plates as specified in other Division 22 sections, provide removable access plates of types and sizes needed for access requirements, as indicated. Provide manufacturer's complete units with anchorages, fasteners and standard factory-applied finishes.
 - 1. Wall/Ceiling Unit Construction: Except as other wise indicated, and where adaptable to substrate, provide manufacturer's standard frameless round formed stainless steel or chrome-plated brass low profile plate cover, with single exposed flush screw anchor, with bright polished finish.
 - 2. Painted Finish: Where substrate is indicated for painted finish, provide steel units with prime-coat paint finish.

2.8 CONCRETE BASES

- A. Provide minimum 4 inch concrete pad (base) under base mounted pumps, boilers, water heaters, floor mounted expansion tanks, glycol tanks and other floor mounted equipment.
- B. Establish the size and location of the various concrete bases required.
 - 1. Water heaters, air compressors and other floor mounted equipment shall have a concrete base at least 4 inches high which shall project 4 inches on all sides beyond the associated equipment.
- C. Furnish necessary anchor bolts and templates to Division 3 for locating and casting into concrete bases.

2.9 DRIP PANS

- A. Provide aluminum sheet metal drip pans with 3/4 inch drain lines below all piping crossing over all electric equipment or control devices. 3/4 inch drain lines should be run to indirect waste at nearest floor drain or plumbing receptacle.

2.10 IDENTIFICATION MATERIALS FOR PIPING

A. Materials for identification shall be as follows:

1. Painted Stencils: Of size and color per ANSI A13.1 using clean cut letters and oil base paint. Paint materials shall be standard exterior type stenciling enamel, brush on or spray can form.
2. Aluminum Tape: 1/2 inch wide aluminum tape, such as DYMO, banded in place around pipe. Imprint only one side of tab.
 - a. Acceptable Manufacturers:
 - 1) Allen Systems, Inc.
 - 2) Brady (W.H.) Co., Signmark Div.
 - 3) Industrial Safety Supply Co., Inc.
 - 4) Seton Name Plate Corp.

PART 3 - EXECUTION

3.1 INSTALLATION OF VALVES

A. General: Except as otherwise indicated, comply with the following requirements:

1. Install valves where required for proper operating of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided when necessary.
2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
3. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
4. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Mechanical Actuators: Install mechanical actuators with chain operators where indicated. Extend chains to about 5 feet above floor and hook to clips to clear aisle passage.

D. 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.

E. 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.

F. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

- G. Examine threads on valve and mating pipe for form and cleanliness.
- H. 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.
- I. Do not attempt to repair defective valves; replace with new valves.

3.2 FREEZE PROTECTION

- A. Do not run lines in outside walls, ventilated attic or ceiling spaces, 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. In attic or ceiling spaces, piping shall be on the warm side of insulation batts. Insulation of piping shall not be considered freeze protection.

3.3 DIELECTRIC CONNECTIONS

- A. Wherever steel and copper pipe are joined in the plumbing or fire protection systems, provide dielectric insulating type unions or flanges as manufactured by Epco Sales Co., or approved equal.

3.4 COPPER WATER PIPING JOINTS

- A. Cut pipe square, remove burrs, and ream. Clean with medium grit emery cloth, flux pipe, fitting with nokorode paste. Use only 95% tin - 5% silver solder.
- B. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- D. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- 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.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- F. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- G. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- H. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9

3.5 WELDING

- A. Use only ASME certified experienced welders with current certificate. Joints between sections of pipe, and between pipe and fittings, shall be fusion welded. Strength of finished welded joints equal to strength of pipe. Width of finished weld shall be at least 2-1/2 times the thickness of the part jointed. Thickness of weld at least 25% greater than the thickness of pipe or fittings. All finished welded joints shall present a neat and workmanlike appearance.
- B. Make no direct welded connections to valves, strainers, apparatus, or related equipment. Make connections to flanged valves or flanged connections with welded flanges.
- C. Radii of weld ells shall be 1-1/2 times nominal diameter of fittings. Fittings used for all branch connections, whether full size or reducing shall be with interior surfaces smoothly contoured. Wall thickness of welding fittings shall be equal to adjacent piping.
- D. Joints between sections of pipe and between pipe fittings, to be fusion welded. Strength of finished weld joints equal to strength of pipe. Width of finished weld at least 2-1/2 times the thickness of the part jointed. Thickness of weld at least 25 percent greater than the thickness of pipe or fittings. Finished welded joints to present neat and workmanlike appearance.

3.6 EXCAVATING FOR PLUMBING WORK

- A. General: Do not excavate for plumbing work until work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum.
- B. Piping run parallel to foundation wall shall be run above 45° plane downward from lowest exterior point of building foundation.
- C. Excavation for Trenches: Dig trenches to uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6 inches to 9 inches of clearance on both sides of piping.
 - 1. Excavate trenches to depth required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups.
 - 2. Where rock is encountered, carry excavation 6 inches below required elevation and backfill with 6 inch layer of crushed stone or gravel prior to installation of pipe.
 - 3. For piping 5 inches or less in nominal size, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support piping on undisturbed soil.
 - 4. For piping 6 inches and larger in nominal size, tanks, and other mechanical work indicated to receive sub-base, excavate to sub-base depth indicated, or if not otherwise indicated, to 6 inches below bottom of work to be supported.
 - 5. Grade bottoms of trenches as indicated, notching under piping couplings to provide solid bearing for entire body of piping.
- D. Shape sub-bases and bottoms of excavations with recesses to receive pipe bells, flanged connections, valves and similar enlargements in piping systems.
- E. Concrete Encasement: Where piping under roadways is less than 2 foot-6 inches below surface of roadway, provide 4 inch base slab of concrete to support piping. After piping is installed and tested, provide 4 inch thick encasement (sides and top) of concrete before backfilling. Provide Class 2500 concrete for encasement and slab.

3.7 BACKFILLING

- A. Do not backfill until installed plumbing and mechanical work has been tested and accepted, wherever testing is indicated.

3.8 CUTTING AND PATCHING

A. Openings in New Construction:

- 1. The Division 22 contractor shall verify all openings required in the new construction in connection with the work under Division 22 with the Architectural and Structural Drawings and shall then meet with and verify same with the General Contractor/Construction Manager who will assign the work to the appropriate contractor to provide all openings in the new construction of the correct size and location in walls, floors or through roofs required for the installation of the plumbing work.

B. Cutting in New Construction:

- 1. Failure on the part of the Division 22 Contractor to make the above arrangements for required openings shall cause the cost of cutting and patching for the necessary openings or the installation of his work to be borne by him, either by having the cutting done by the appropriate contractor as assigned by the General Contractor or in the form of performing the required cutting himself. In either case, all patching shall be done by the appropriate finishing contractor as determined by the General Contractor; no cutting or drilling of holes shall be done without approval of the Structural Engineer/Engineer.

C. Patching in New Construction:

- 1. The appropriate finishing contractor as determined by the General Contractor shall patch all openings in the new structure. All openings made in fire-rated walls, floors, or ceilings, shall be patched and made tight to conform to the fire rating for the enclosure. All materials used in patching shall match the materials specified in the Architectural Specifications and all patched areas shall be restored to the specified finish surface to the satisfaction of the Structural Engineer.

- D. The Division 22 Contractor shall pay the appropriate Finishing Contractor as determined by the General Contractor for all patching resulting from cutting to accommodate plumbing.

3.9 PIPING INSTALLATION

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Materials and methods shall be per applicable portions of ASM, ASTM, ASA, AWS, and applicable Plumbing Code.
- C. Provide proper grades, slopes, elevations with readily accessible drainage connections at low points so entire systems may be completely drained. Allow for expansion and contraction to avoid distortion, damage, improper operation. Make certain piping above and below grade is not inadvertently anchored; if questionable, obtain clarification.
- D. Arrange, install piping approximately as indicated. Install straight, plumb, and as direct as possible. Form right angles or parallel lines with building walls. Keep pipes as close to walls,

partitions, ceilings as possible. All piping to be concealed in building construction unless noted or shown otherwise. Keep fixture branches concealed except for final connection.

- E. Interference with Other Trades: Before installing piping, check plumbing drawings with all other drawings and arrive at mutual agreement with other trades where interferences may occur. Obtain approval of proposed changes.
- F. Protect Open Piping: Keep piping free from scale and dirt. Protect open pipe ends whenever work is suspended during construction.
- G. Drawing plans, schematics, and diagrams 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 unless deviations to layout are approved on Coordination Drawings.
- H. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- I. 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.
- J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- K. Install piping to permit valve servicing.
- L. Install piping at indicated slopes.
- M. Install piping free of sags and bends.
- N. Install fittings for changes in direction and branch connections.
- O. Install piping to allow application of insulation.
- P. Select system components with pressure rating equal to or greater than system operating pressure.
- Q. Verify final equipment locations for roughing-in.

3.10 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 inches and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 inches and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals. For NPS 2 and smaller: use dielectric couplings with nipples or unions.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals. For NPS 2 and smaller: use dielectric couplings with nipples or unions

3.11 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
 - 1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated by Structural Engineer, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Place and secure anchorage devices. Use supported equipment manufacturer's 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.
 - 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 6. Use 4000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Sections.

3.12 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, 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.
- C. Install powder-actuated drive-pin fasteners 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.
- D. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- F. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- G. Install stainless steel hangers and supports in Wash Bay.
- H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," are not exceeded.

- J. All Insulated Piping: Comply with the following:
1. Install MSS SP-58, Type 40 protective shields on cold and hot piping with vapor barrier. Shields shall span arc of 180 degrees.
 2. Apply insulation continuously through hangers.
 - a. Piping 1-1/2 inches and below and operating below Ambient Air Temperature: Apply insulation continuously through hangers. Protect insulated horizontal pipe at point of support with 180 degree, 12 inch long sheet metal thermal-hanger shield. No hanger shall penetrate or crush insulating material.
 - b. Piping 1-1/2 inches and below and operating above Ambient Air Temperature: Apply insulation continuously through hangers. Protect insulated horizontal pipe at point of support with 180 degree, 12 inch long sheet metal thermal-hanger shield. No hanger shall penetrate or crush insulating material.
 - 1) At contractor's option: Wrap pipe and hanger. Hangers sized for piping. Clamp may project through insulation.
 - c. Do not exceed pipe stress limits according to ASME B31.9.
 3. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

3.13 TESTS

- A. General: Provide test pump, gauge, meters, other instruments, materials, labor, in connection with tests.
- B. Pressure Tests: Before testing piping systems, remove or otherwise protect from damage, control devices, air vents, and other parts, which are not designed to stand pressures used in testing piping.

3.14 PIPE IDENTIFICATION

- A. Identify system components. Label pressure piping with system operating pressures.
- B. General Installation Requirements
 1. All piping identification system shall be in full compliance with ASTM Standards.
 2. All piping is to be identified with initials and flow arrows. Labels are to be stenciled; stick-on labels are not acceptable.
- C. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- D. Piping System Identification

1. Aluminum Tape: Shall be utilized on piping systems ½ inch diameter and less. Imprinting shall be applied to one side of tape only, with lettering 3/16 inch high.
2. Painted Stencils: Stenciled marking shall be neatly performed with no overspray, drips, or other imperfections. Pipes and equipment to be stenciled shall first be wiped clean of dirt, dust, rust, grease and moisture. Comply with Painting Specifications Section 09 90 00.

E. Size of Color Field and Letters for Stencils:

<u>Insulation or Pipe Diameter</u>	<u>Length of Color Field</u>	<u>Size of Letters</u>
3/4" to 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"
Equipment	NA	2-1/2"

- F. Entire gas line shall be painted yellow and labeled with black lettering per this section.
- G. All pipe identification systems shall be visible from a normal observation position.
- H. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior non-concealed 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 through walls, floors, ceilings, and non-accessible 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 along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.
 8. Provide a directional flow arrow adjacent to all pipe identification.

I. Legend:

<u>Type</u>	<u>Medium</u>	<u>Symbol</u>	<u>Field Color</u>	<u>Letter Color</u>
Gas	Natural Gas	NG	Yellow	Black
Waste	Sanitary Sewer	SAN	Green	White
Waste	Sanitary Vent	V	Green	White
Water	Domestic Cold Water	DCW	Green	White
Water	Domestic Hot Water	DHW	Yellow	Black
Water	Heating Water Supply with Glycol (Util. & Air Cond.)	HWS/G	Yellow	Black
Refrigerant	Refrigerant Liquid	RL	Blue	White
Refrigerant	Refrigerant Suction	RS	Blue	White
Air	Compressed Air	CA	Blue	Blue

J. Valve Identification

1. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of

end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

3.15 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

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SECTION 22 10 00
PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.
- B. Related Sections:
 - 1. Section 22 00 00: Plumbing General Requirements
 - 2. Section 22 05 00: Common Work Results for Plumbing

1.2 GENERAL

- A. Pipe Workmanship: Piping shown on drawings shall be installed complete, and shall be of the size shown on the drawings.
- B. When a size is not indicated, the subcontractor shall request the pipe size from the Engineer or CDOT Representative through the General Contractor. All piping shall be installed parallel or perpendicular to the building construction. All piping shall be installed so as to allow for expansion.
- C. Piping Joints: All pipe shall be reamed to full pipe diameter before joining. Soldered joints shall be made with 95%-5% tin-silver solder metal per ASTM B32-89, alloy Grade 95TS, Canfield 100% Watersafe (or approved equal). Screwed joints shall be made with standard pipe thread, and an approved compound applied to the male thread only. Welded joints shall be made in accord with the procedure outlined in the U.S.A. Piping Code, and each welder shall be certified by the National Certified Pipe Welding Bureau, or by other reputable testing laboratory or agency. Subcontractor shall use only "Threadolet" or "Weldolet" fittings for intersection welding of branches to mains. Valves and specialties shall have screwed or flanged joints.
- D. Piping Supports: All pipe shall be supported from building structure in a neat and workmanlike manner. Wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. Vertical risers shall be supported at each floor line with steel pipe clamps. The use of wire or perforated metal to support pipes will not be permitted.

1.3 SUBMITTALS

- A. Shop Drawings and Product Data: Submit the following in accordance with Sections 01 33 00 and 22 00 00.
 - 1. Cast Iron Pipe
 - 2. No Hub Couplings
 - 3. Copper Pipe
 - 4. Solder
 - 5. Steel Pipe
 - 6. Aluminum Air Piping Systems
 - 7. PVC

PART 2 - PRODUCTS

2.1 STRAINERS

- A. Strainers in steel piping systems, 2 inches and smaller shall be McAlear style SG, semi-steel body, screwed, Y-pattern ASTM A126-84, Class B, with a 20 mesh screen.
- B. Strainers in copper piping systems 2 inches and smaller shall be McAlear No. 539S, cast bronze base stainless steel screen.

2.2 BALANCE COCKS

- A. All balance cocks to be eccentric type, suitable for 250 degF continuous service and dead shut-off, DeZurik Fig. 425 with adjustable balance stop, or equal by A.C.F. Industries, Bell & Gossett, or Illinois Valve Co.

2.3 UNIONS

- A. (Screwed Piping) Malleable iron, ground joint, brass to iron seat, Grinnell Fig. 463 or Grabler.
- B. (Copper Tubing) Brass with soldered joints.

2.4 PIPE AND FITTINGS

- A. Shall be of material, weight, ASTM and ANSI Designation, and pressure ratings as follows unless specifically excepted otherwise. All pipe shall be new, clean and free of all rust.

2.5 SANITARY WASTE AND VENT UNDERGROUND INSIDE BUILDING

- A. Include 10 feet plus or minus outside of building wall.
- B. PVC Pipe: ASTM D2665 or ASTM D3034 SDR 26, polyvinyl chloride (PVC) material.
- C. Fittings: PVC, ASTM D2665 or ASTM D3034.
- D. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.6 SANITARY WASTE AND VENT UNDERGROUND FROM 10 FEET OUTSIDE BUILDING LINE

- A. Pipe: PVC Pipe, ASTM 2665.
- B. Joints: Resilient joint with "O" ring seals, ASTM C-425-91, Type III
- C. Fittings: Correspond to pipe in material, class and ASTM Designation.
- D. Joints: Compression, rubber gasketed; install in accordance with ASTM D2321.
- E. Where required and as indicated on the drawings (only applicable to off site, not paved areas)
 - 1. Pipe: Schedule 80 PVC, ASTM D-2665-91B, SDR-35, Type PSM.

2.7 SANITARY SOIL, WASTE AND VENT, ABOVE GROUND INSIDE BUILDING

- A. PVC Pipe: ASTM D2665 or ASTM D3034 SDR 26, polyvinyl chloride (PVC) material. Transition to cast iron pipe where pipes are exposed, PVC pipe allowed once above roof, terminate with goose neck and screen.
- B. Fittings: PVC, ASTM D2665 or ASTM D3034.
- C. Joints: ASTM D2855, solvent weld with ADTM D2564 cement.

2.8 DOMESTIC WATER SERVICE OUTSIDE OF BUILDING

- A. 3 inch and larger shall be Ductile Iron Pipe: AWWA C151
 - 1. Fittings: AWWA C110, ductile iron, standard thickness
 - 2. Joints: AWWA C111, rubber gasket with rods
 - 3. Jackets: AWWA C105 polyethylene jacket
- B. 2-1/2 inch and smaller shall be Type "K" soft drawn copper, ASTM B88.
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Compression connection or Brazed, AWS A5.8 BCup silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F

2.9 DOMESTIC HOT AND COLD WATER UNDERGROUND INSIDE BUILDING

- A. Include 5 feet plus or minus outside of building wall.
- B. 2-1/2 inch and Under:
 - 1. Pipe: Copper water tube, heavy wall thickness, annealed temper; ASTM B 88-92, Type K
 - 2. No fittings or joints allowed underground, below floor slabs.

2.10 DOMESTIC COLD WATER AND HOT WATER ABOVE GROUND INSIDE BUILDING

- A. 2-1/2 inch and Under:
 - 1. Pipe: Type L, seamless copper tubing ASTM B88-92 (hard drawn for all horizontal and all vertical lines)
 - 2. Fittings: Wrought copper or bronze solder joint pressure type fittings per ANSI B16.22-1989
 - 3. Joints: 95%-5% tin-silver solder metal per ASTM B32-89, alloy Grade 95TS, Canfield 100% Watersafe (or approved equal).

2.11 NATURAL GAS PIPING

- A. Underground or embedded in concrete:
 - 1. Pipe: Schedule 40, black seamless steel pipe per ASTM A53-90b, Type S, Grade B with protective coating as hereinafter specified.

2. Fittings: Schedule 40, standard radius, dimension per ASTM A234 Grade WPB.
 3. Joints: Butt-welded.
- B. Above ground, inside or outside in building:
1. Pipe: Schedule 80 for pipe sizes 1/2 inch and under; Schedule 40 for pipe sizes over 1/2 inch, black welded or seamless steel pipe per ASTM A53-90b.
 2. Fittings:
 - a. 1/2 inch and Under: 300 pound malleable iron flat banded pattern screwed fittings per ANSI B16.3-85.
 - b. Over 1/2 inch to 1-1/2 inches: Same as above except 150 pound class, screwed or welding fittings per joints below.
 - c. Over 1-1/2 inches: Schedule 40, seamless carbon steel welding fittings, long radius, 150 pound class, dimensions per ANSI B16.9-1986; ASTM A234, Grade WPB.
 3. Joints:
 - a. 2 inches and Under: Threaded using joint compound resistant to gas- air mixture, such as "gasolia".
 - b. 2-1/2 inches to 4 inches: Butt-welded.

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SECTION 23 00 00
HEATING, VENTILATING AND AIR CONDITIONING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.
- B. In case of disagreement between drawings and specifications, or within either document itself obtain written clarification from the Mechanical Engineer through the CDOT Representative. Failure to obtain clarification prior to bid will result in the better quality and greater quantity being required during the construction phase, without additional reimbursement.

1.2 SUMMARY OF WORK

- A. Work Included: Unless specified otherwise, provide all supervision, labor, materials, transportation, equipment, hauling, and services necessary for completely finished and operational mechanical systems. Provide all minor incidental items such as offsets, fittings, etc. required as part of the work even though not specifically shown on contract drawings or specifications. All work included by virtue of these specifications shall be free from all defects which may be caused by computerized data features.
- B. The Contractor shall provide and install the number of items of equipment as indicated on the drawings, and as required for code-compliant systems.
- C. Description of Systems: The work of Division 23 includes but is not limited to:
 - 1. Heating, Cooling and Ventilating
 - 2. Temperature Control and Instrumentation
 - 3. Testing, Adjusting & Balancing
- D. Related Divisions:
 - 1. Division 3 for fixed concrete bases and/or pads for Mechanical equipment.
 - 2. Division 9 for painting except mechanical identification systems.
 - 3. Division 22 for piping to mechanical systems.
 - 4. Division 23 for mechanical equipment, wall openings and chases.
 - 5. Division 26 for power wiring and disconnect switches which are not furnished as an integral part of mechanical equipment.
- E. Inspection: GC to inspect work preceding or interfacing with work of Division 23 sections prior to construction and report all known or observed defects that affect the mechanical design to the CDOT Representative. Do not proceed with the construction work until defects are corrected.

1.3 EXAMINATION OF CONTRACT DRAWINGS AND SPECIFICATIONS

- A. Material and equipment has been carefully selected for this project, and the Contractor is expected to provide all items as closely as possible to the specifications.

- B. The mechanical drawings show the general arrangement of all piping, ductwork, mechanical equipment, and appurtenances, and shall be followed as closely as actual building construction and the work of their trades will permit.
- C. The architectural and structural drawings shall be considered part of the mechanical work insofar as these drawings furnish this Division with information relating to design and construction of the building.
- D. Because of the small scale of the mechanical drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Investigate the structural and finish conditions affecting the work and provide such fittings, valves and accessories as may be required to meet such conditions.
 - 1. Verify dimensions governing mechanical work at the building. Do not scale the mechanical drawings for dimensions. Take dimensions, measurements, locations, levels, etc. from the architectural drawings and the approved shop drawings submitted on the actual equipment to be furnished.
 - 2. No extra compensation shall be claimed or allowed on account of differences between the actual dimensions and those indicated on the drawings.
 - 3. Examine all adjoining work on which the mechanical work is dependent for maximum efficiency and report all design conflict which must be corrected prior to submitting bid. No waiver of responsibility shall be claimed or allowed due to failure to report unfavorable conditions affecting the mechanical work.
- E. Submission of a bid constitutes acceptance of Drawings and Specifications as sufficiently detailed and complete to provide a complete, properly-functioning installation in conformance with applicable codes, standards and ordinances.
- F. Omission of words or phrases such as "the Contractor shall", "in conformity therewith", "shall be", "as noted on the drawings", "a", "an", "the", "all", etc. are intentional. Omitted words and phrases shall be supplied by inference in the same manner as they are when a "note" appears on the Drawings. "Provide" is intended to mean furnish and install.
- G. Order of Precedence: The precedence of mechanical construction documents is as follows:
 - 1. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.
 - 2. Should there be a conflict within the Specifications or within the Drawings of the same scale, the more stringent or higher quality requirements shall apply.
 - 3. In the Drawings, the precedence shall be Drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions and noted materials over graphic indications.
 - 4. Should a conflict arise between the Drawings and the Specifications for products indicated on the Drawings and the Specifications, the Specifications shall have precedence.

1.4 EXAMINATION OF PROJECT SITE

- A. Examine site carefully to determine conditions to be encountered, work to be performed, equipment, and materials to be transported, stored, furnished, other features applicable to completion of the work.
- B. Study drawings and specifications, report inconsistencies, errors, omissions, conflicts with codes and ordinances.
- C. Submittal of bid will indicate satisfactory field examinations made, applicable allowances included in the bid.

1.5 COORDINATION

- A. The Contractor shall plan all of his work in advance, and shall inform the CDOT Representative of the proposed construction schedule and anticipated completion date upon request. Contractor shall complete the entire installation as soon as the condition of the remaining building construction will permit.
- B. Location of pipes, ducts, switches, panels, equipment, and fixtures, shall be adjusted to accommodate the work or interferences anticipated and encountered. Determine the exact route and location of each pipe and duct prior to fabrication.
 - 1. Right of way: Lines which pitch shall have the right-of-way over those which do not pitch. Lines whose elevations cannot be changed shall have right-of-way over lines whose elevations can be changed.
 - 2. Offsets, Transitions, and Changes in Direction: Offsets, transitions and changes in direction of pipes and ducts shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings.
 - 3. Furnish and install all traps, air vents, sanitary vent, and devices as required to affect these offsets, transitions, and changes in direction.
 - 4. Furnish and install all required mechanical system piping insulation both inside and outside as recommended by manufacturer.
- C. Where major conflicts occur, contractor shall rely upon the CDOT Representative to make final decision regarding priority of right of way. Contractor shall request written clarification from the CDOT Representative prior to conflict reaching critical stage requiring removal of previously installed equipment or system components either by himself or by other trades involved.
- D. When directed by the CDOT Representative, submit shop drawings showing interrelationship of various portions of work and work of other trades. Failure to properly coordinate may result in removal and relocation at no expense to the Owner.
- E. Locations of existing utilities are based on the best information available. Contractor to hire independent locating company to verify exact locations of all utilities prior to fabrication and erection of work to avoid all interferences. Verification shall be by site inspection, excavation, or whatever means necessary to determine exact location of utilities. Interferences shall be avoided at no extra cost. If hidden utilities are encountered after Contractor's locating company's investigation, it is at the Contractor's cost to rectify hidden utility issues in a code-compliant manner. Contractor must notify Owner when a hidden utility is encountered. Utilities (including services) shall mean items such as pipes, and associated items such as valves, coating, and coverings. An item shall not be considered hidden if accessible, e.g. if above lay-in ceilings, if behind access panels, or if in other similar locations.

1.6 FUTURE SERVICE AND MAINTENANCE ACCESSIBILITY

- A. Install all mechanical equipment so as to allow proper service access to equipment as recommended by equipment manufacturer. Do not install any portion of the mechanical system in such a manner as to eliminate or inhibit service access required on equipment installed by another trade on the project.
- B. Install mechanical work to permit removal of heat exchanger bundles, filters, belt guards, sheaves, drives, and other parts requiring periodic replacement or maintenance without damage to or interference with other parts of equipment or structure. All mechanical equipment shall be replaceable (dismantled) without requiring the removal of permanent building components. Alert Engineer if such conditions do not exist.
- C. Arrange pipes, ducts, and equipment to permit ready access to valves, cocks, traps, starters, motors, control components, and to clear the openings of swinging doors and access panels.
- D. If required for better accessibility, furnish access doors for the purpose. All changes shall be approved by the CDOT Representative prior to making the change.
- E. This Contractor shall provide the General Contractor with the exact locations of access panels for each concealed valve, control, damper or other device requiring service. Locations of these panels shall be submitted for approval in sufficient time to be installed in the normal course of work.

1.7 UTILITY INTERRUPTIONS

- A. Coordinate mechanical utility interruptions with the Owner and the Utility Company. Plan work so that duration of the interruption is kept to a minimum. This contractor shall be responsible for informing all adjacent tenants or building owners of a pending utility interruption. Contractor shall coordinate the utility interruption in a practical manner which is most convenient to all outside parties so affected.

1.8 OPENINGS THROUGH BUILDING CONSTRUCTION

- A. This contractor shall cooperate with the General Contractor and all other Contractors whose work is the same space, and shall advise General Contractor of his requirements. Such spaces and clearances shall, however, be kept to the minimum size required.
- B. This Contractor shall see that all slots and openings through floors, walls, ceilings and roofs are properly located and shall do all cutting and patching caused by neglecting to do so.
 - 1. Furnish sleeves, inserts, supports, and equipment that are to be installed by others in sufficient time to be incorporated into construction as the work proceeds.
 - 2. It is the responsibility of this contractor to locate these items and see that they are properly installed.

1.9 CODES, ORDINANCES, PERMITS AND FEES

- A. Execute work per underwriters, public utility, local, state codes, ordinances, and regulations applicable.

- B. This Contractor shall include in the work, all labor, materials, services, apparatus and drawings, in order to comply with all applicable laws, ordinances, rules and regulations, whether or not shown on drawings and /or specified.
- C. All materials furnished and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, with the requirements of local utility companies, and with the requirements of all governmental departments having jurisdiction. In the event of a conflict, applicable codes and ordinances shall take precedence over this specification or contract drawings.
- D. All material and equipment for the electrical portion of the mechanical systems shall bear the approval label of, or shall be listed by the Underwriter's Laboratories, Incorporated, and shall be installed in compliance with the National Electric Code.
- E. Comply with all applicable codes and standards referenced in Section 01 42 19.

1.10 SUBMITTALS

- A. Within thirty days after award of the Contract submit to CDOT Representative complete catalog data and/or shop drawings for each item of material and for every manufactured item of equipment to be used in the work. Such data shall include specific performance data, material description, rating, capacity, dimensions, and type for each item of material, each manufactured item, and all component parts utilized in final operating mechanical system. Applicable data shall be underlined and each applicable item identified in each catalog by the same identification acronyms used on the Drawings.
- B. This Contractor shall submit to the CDOT Representative the number of copies required by the Division 1 General Requirements.
- C. Each item submitted shall bear the Contractor's stamp, be dated and signed certifying that they have reviewed and approved the submittal.
- D. The review comments of the CDOT Representative, the Architect, and/or code reviewer shall not relieve the Contractor from responsibility for deviations or errors from the Drawings or Specifications.

1.11 REQUESTS FOR SUBSTITUTION

- A. Contractors desiring to use alternate equipment or materials and manufacturers or suppliers desiring to furnish alternate materials or equipment in lieu of those specified, shall submit requests for approval to the CDOT Representative not less than the due date of questions for the Second Addenda, which date will be delineated in Addendum # 1, so that answers can be included in Addendum #2.
- B. Requests for approval shall be made in writing and shall include complete data sheets, and catalogue cuts and shall identify all maintenance procedures deviating from that of the specified equipment.
- C. Contractor shall be responsible for proper installation, complete in all respects, and operation of all equipment or materials substituted as a result of approval of requests to substitute, including all required modifications in work to be accomplished by the other trades involved.
- D. This contractor shall be responsible for the proper location, capacity, and quantity of all rough-ins and connections to substituted equipment by members of other trades involved.

1.12 ELECTRIC WIRING AND SAFETY DEVICE WORK AND MATERIAL RESPONSIBILITIES

- A. Furnish equipment requiring electrical connection to operate properly, deliver full capacity at electrical service available.
- B. All control wiring to be in accord with manufacturer's recommendations, and all wiring shall be color coded to facilitate checking.
- C. Unless otherwise indicated, all mechanical equipment motors and controls shall be furnished, set in place, and wired in accordance with the following schedule: (MD = Mechanical Division; ED = Electrical Division)

<u>ITEM</u>	<u>FURNISHED UNDER</u>	<u>SET IN PLACE OR MOUNTED UNDER</u>	<u>POWER WIRED & CONNECTED UNDER</u>	<u>CONTROL WIRED & CONNECTED UNDER</u>
Equipment Motors	MD	MD	ED	--
Magnetic Motor Starters:				
a. Automatically controlled with or without HOA switches	MD	MD	ED	MD
b. Manually controlled	MD	MD	ED	MD
c. Manually controlled and furnished as part of factory wired equipment	MD	MD	ED	MD
Line voltage thermostats, etc. not connected to control panel systems	MD	ED	ED	ED
Temperature control panels and time switches mounted on temperature control panels	MD	MD	ED	MD
Motorized damper motors	MD	MD	ED	MD
Control circuit feeders	ED	ED	ED	ED
Low voltage controls, thermostats, etc.	MD	MD	ED	ED
Water heater controls, panels, internally				

wired	MD	MD	ED	MD
<u>ITEM</u>	<u>FURNISHED UNDER</u>	<u>SET IN PLACE OR MOUNTED UNDER</u>	<u>POWER WIRED & CONNECTED UNDER</u>	<u>CONTROL WIRED & CONNECTED UNDER</u>
Fused and unfused disconnect switches, thermal overload switches, manual operating switches	ED	ED	ED	--
Multi-speed switches	MD	ED	ED	ED
Contactors	ED	ED	ED	ED
Control relays, transformers	MD	ED	ED	ED

- D. Make Connections to controls directly attached to ducts, piping and mechanical equipment with flexible connections.
- E. All temperature control conduit and wiring will be furnished and installed under electrical contract. All motorized damper wiring will be furnished and installed under temperature control subcontract. In the event that temperature control is not under separate contract, Mechanical Contractor shall assume all temperature control subcontract responsibilities.
- F. Division 26 shall furnish and install all conduit required for power wiring to all mechanical equipment.
- G. Mechanical Contractor shall provide Electrical Contractor with a complete summary list of all mechanical equipment requiring electric power within 30 days after award of contract. This list shall summarize equipment power loads, quantities, and locations of equipment and connection points.

1.13 QUALITY ASSURANCE

- A. Preparation: Base final installation of materials and equipment on actual dimensions and conditions at the project site. Field measure for materials or equipment requiring exact fit.
- B. Workmanship: Perform work in a workmanlike manner. The good appearance of the finished work shall be important.
- C. Supervision: Be responsible for and coordinate the work of all sub-contractors working under Division 23.
- D. Installation Procedures: Confer and cooperate with other trades and coordinate the work in proper relation with theirs. Coordinate wall/ceiling cavity space carefully with other trades, prior to commencing installation of mechanical equipment.
- E. Properly locate anchors, chases, recesses and openings required for the proper installation of the work. Arrange with the proper Contractors for the building of anchors, etc. and for the leaving of the required chases, recesses and openings.

- F. Install equipment and materials in accordance with manufacturer's recommendations unless specifically indicated otherwise, or where local codes or regulations take precedence.
- G. Protection:
 - 1. Close ends of pipe and ductwork during construction to prevent entry of foreign material. Protect insulation against dirt, water, chemical or mechanical damage before, during and after installation (prior to owner acceptance of jobs). Protect fixtures and equipment against damage during mechanical work. Protect filters and coils from construction debris at air handling equipment, including terminal units by wrapping equipment with plastic.
 - 2. Pay for damage, injury or loss caused by negligence or errors of Division 23 Contractors. Post effective danger signs warning against hazards created by work.

1.14 DELIVERY, STORAGE AND HANDLING

- A. General: Comply with Division 1 General and Special Requirements.
- B. Protection: Make provisions for coordination with Owner and other Contractors for safe storage of materials and equipment.
 - 1. Store materials and equipment off the ground and under cover, protected from damage.
- C. Large Items: Schedule delivery of large equipment requiring special openings, as required for installation without delaying the work of other project trades.
- D. Acceptance: Check and sign for materials to be furnished by Division 23 and other trades for installation under Division 23 upon delivery. Assume responsibility for the storage and safekeeping of such materials from time of delivery until final acceptance.

1.15 SCAFFOLDING, RIGGING AND HOISTING

- A. This Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of all equipment and apparatus furnished. Remove same from premises when no longer required.

1.16 QUIET OPERATION AND VIBRATION

- A. All work shall operate under all conditions of load without sound or vibration which is objectionable in opinion of the Owner. In case of moving machinery, sound, or vibration noticeable outside of room in which it is installed, or annoyingly noticeable inside its own room, will be considered objectionable by the Architect and Owner, and shall be corrected in an approved manner by this Contractor at his expense. Vibration control shall be by means of approved vibration isolation devices as specified in Section 23 05 48 - Vibration Controls for HVAC.

1.17 CLEANING

- A. Clean exposed surfaces of piping, hangers, ducts, and other exposed items of grease, dirt or other foreign material. At the completion of the work, remove rubbish and debris resulting from the construction operations and leave equipment and building spaces clean and ready for use.

- B. Provide and install new filters to all equipment utilizing throwaway filters prior to and at completion of test and balancing of all air handling equipment. Clean all permanent filters.

1.18 TESTS AND SCHEDULE OF TESTING

- A. Demonstrate the proper operation of equipment installed under this project
- B. Equipment shall not be tested, or operated for any purpose until fully lubricated in accordance with manufacturer's instructions and until connections to fully operative systems have been accomplished.
- C. A schedule of testing shall be drawn up by the Mechanical Contractor in such a manner that it will show areas tested, test pressure, length of test, date, time, ambient or surrounding air temperature at beginning and conclusion of test, and signature of testing personnel.
- D. All testing must be performed in the presence of the General Contractor or authorized agent, and his signature for verification of the test must appear on the schedule.

1.19 PROJECT RECORD DOCUMENTS

- A. One set of contract drawings shall be kept current by the Contractor during construction to indicate all deviations from the plans in the actual installation.
- B. Job site Documents: Maintain at the job site, one record copy of the following:
 - 1. Drawings
 - 2. Specifications
 - 3. Addenda
 - 4. Reviewed Shop Drawings
 - 5. Field Test Records
- C. Do not use record documents for construction purposes. Maintain documents in clean legible condition, apart from documents used for construction.
- D. Record Information: Label each document "Record Document". Mark information with contrasting color using ink. Keep each record current. Do not permanently conceal any work until required information is recorded.
 - 1. Record following information on Record Drawings:
 - a. Horizontal and vertical location of underground utilities
 - b. Location of internal utilities and appurtenances concealed in construction
 - c. Field changes of dimension and detail
 - d. Changes by change order or field order
 - e. Details not on original contract drawings
 - f. Record following information on Specifications
 - g. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed
 - h. Changes by change order or field order
 - i. Other matters not originally specified
- E. Shop Drawings: Maintain Shop Drawings as record documents recording changes made after review as specified for drawings above.

- F. Submittal: At completion of project, deliver Project Record Documents to General Contractor for delivery to CDOT Representative

1.20 OPERATION AND MAINTENANCE DATA

- A. See Section 01 78 23 Operations & Maintenance Manuals for specific directions on preparing Manuals.
 - 1. Completed Test, Adjust, and Balance Report.
 - 2. Copy of original mechanical specification complete with all applicable addendums.
- B. Completed and corrected Operation and Maintenance manuals shall be delivered to General Contractor prior to final payment to Mechanical Contractor.

1.21 WARRANTIES

- A. In accordance with Division 1, provide a written warranty to the Owner covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of one year after Date of Acceptance. During this period provide labor and materials as required to repair or replace defects at no additional cost to the Owner. Provide certificates for such items of equipment which have warranties in excess of one year. Submit to the General Contractor.
- B. All compressorized equipment, including but not limited to condensing units shall be provided with minimum 5 year compressor warranty.

1.22 CERTIFICATES AND KEYS

- A. Certificates: Upon completion of the work, submit one copy of Certificate of Final Inspection to CDOT Representative as part of the Yellow Card Inspection Report.
- B. Keys: Upon completion of work, submit two (2) keys for mechanical equipment, panels, etc. to the CDOT Representative. Clearly label key to equipment type.

1.23 SITE OBSERVATIONS

- A. From time to time, the Architect, CDOT Representative and/or Engineer shall make observations of the construction progress and general quality of the construction.
- B. Engineer shall not be responsible for continuous or excessively detailed site observations to verify the quality or quantity of construction work accomplished.
- C. Engineer shall not be responsible for Contractor's failure to carry out construction work in accordance with the Contract documents, and/or failure to maintain sound and safe construction procedures or practices.
- D. Engineer shall provide CDOT Representative with a typed list of site observation comments or "Punch List". It shall remain the responsibility of the General Contractor to see that all items incorporated within the typewritten list of comments are accomplished by the Mechanical Contractor.

- E. The failure of the Engineer to identify all construction procedures conflicting with the intent of the Mechanical Construction Documents shall not relieve the Contractor of his responsibility to provide a complete, operable and efficiently installed mechanical system.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

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SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section
- B. Work Included in This Section:
 - 1. Plates and Collars
 - 2. Flashings and Seals
 - 3. Access Doors
 - 4. Excavating for Mechanical Work
 - 5. Backfilling
 - 6. Cutting and Patching
 - 7. Heating System Used for Temporary Heat During Construction
 - 8. Concrete Bases
 - 9. Drip Pans
 - 10. Tests
 - 11. Identification Materials for Equipment
- C. Related Sections
 - 1. Section 08 31 13: Access Doors and Frames
 - 2. Division 22 and 23 Sections
 - 3. Section 26 05 00: Common Work Results for Electrical

1.2 QUALITY ASSURANCE

- A. Superintendent: This Contractor shall furnish the services of an experienced superintendent. Said superintendent shall have successfully completed a minimum of four (4) projects of similar size and scope previous to the commencement of all work on this project. He shall be in constant charge of all skilled workman, fitters, metal workers, welders, helpers, and labor required to unload, transfer, erect, connect-up, adjust, start, operate, and test for each system specified within this mechanical specification.

1.3 REFERENCES

- A. Comply with applicable requirements of the following standards:
 - 1. Air Movement and Control Association (AMCA)
 - 2. Canadian Gas Association (CGA)
 - 3. American Water Works Association (AWWA)
 - 4. ANSI B31 Code for Pressure Piping
 - 5. National Certified Pipe Welding Bureau (NCPWB)
 - 6. National Electric Code (NEC)
 - 7. National Electrical Manufacturers Association (NEMA)
 - 8. National Fire Protection Association (NFPA)

9. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
10. Underwriters Laboratories (UL)

1.4 EQUIPMENT AND MATERIALS

- A. Materials and apparatus required for the work is to be new, of first class quality, and is to be furnished, delivered, erected, connected, 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, as approved by CDOT Representative.
- B. All materials shall bear the Manufacturer's name and trade name. Equipment and materials of the same general type shall, as much as is feasible, be of the same make throughout the work to provide uniform appearance, operation, and maintenance.
- C. Unless otherwise specifically indicated, equipment and materials shall be installed in accordance with the recommendations of the manufacturer. This includes the performance of such operational tests as recommended by the manufacturer.

PART 2 - PRODUCTS

2.1 PLATES AND COLLARS

- A. Provide tight fitting cover plates on cleanout openings in walls, ceilings, and floors, chrome plated in finished areas, galvanized cast iron in unfinished areas and mechanical rooms.
- B. Provide duct collars for ducts passing through walls, floors and ceilings, chrome plated in finished areas, galvanized sheet metal in unfinished areas and mechanical rooms.

2.2 FLASHING AND SEALS

- A. Steel Flashing: 26 gauge galvanized sheet metal, to match roof contour.
- B. Flexible Neoprene Pipe Flashing: One piece, cone shaped, seamless, molded, 0.060 inch thick uncured neoprene, water absorption maximum one percent (1%) by weight, tensile strength minimum 1800 psi, elasticity minimum three hundred percent (300%) with full recovery without set, match color of surrounding roofing.
- C. Modular Mechanical Type Waterproof Seal: Interlocking synthetic rubber links, sized to fill annulus between pipe or conduit and wall opening. Rubber links expanded to form watertight seal with zinc coated bolts.
- D. Fire Barrier Sealant: Firestop type putty such as "Flameseal" manufactured by Nelson Co. shall be packed within annular space surrounding pipe or duct by Mechanical Contractors on both sides of wall or floor. UL classified as "Wall Opening Protective Device," non-toxic, non-allergenic before and after cure. Material must meet requirements of NEC (NFPA), Article 300-21. Material must seal watertight, be of sufficient viscosity to withstand direct fire hose impact, less than flame spread 25, fuel contributed 25, and ASTM E 814 shall not be exceeded. Other acceptable manufacturers are 3M (Fire Barrier), IPC (Flamesafe) and Dow Corning (System 2000). Fire barrier sealant shall meet requirements of UL Standard 1479.

2.3 MOTORS

A. General:

1. Furnish motors necessary to operate mechanical equipment. Verify motor characteristics shown on mechanical drawings with those shown on electric drawings before ordering equipment. Have conflicts clarified by CDOT Representative.
2. Requirements for horizontal and vertical alternating current induction motors for general purpose application shall conform to the following requirements unless otherwise noted or required for a particular application.
3. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.
4. Each direct-connected motor shall be securely mounted and accurately aligned. The drive must be free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures. Belt drives and flexible coupled direct drives shall be aligned after final installation.
5. The horsepower of motors specified or indicated on the drawings are those estimated to be required, and have been used to determine the electric feeder sizes. If the actual horsepower required for all equipment to be furnished differs from that specified, or shown on the drawings, the matter must be referred to the Engineer for adjustment before installation in accordance with the requirements of Division 26.
6. Each motor shall have capacity to start and operate the machine it drives adequately for the duty to be performed without exceeding its full rated load or safe operating temperature when the driven equipment is operating at specified capacities with ambient temperatures and altitude compensation for actual job conditions or at all speeds and loads which may be obtained by the driver actually furnished.
7. Dry Areas: NEMA design B with Class B insulation for three phase motors where normal starting torque is adequate. NEMA design C motors with Class F insulation for high starting torque loads.
8. Wet Areas: NEMA 4 rated with Class F insulation for high starting torque loads.

B. Motor Characteristics:

1. Altitude Deration: Motors to be furnished to maintain specified rated service factor at the altitude of the project.
2. NEMA Temperature Rating: Rated for 40° C environment for continuous duty at full load.
3. Starting Characteristics: Each motor provided with automatic control shall also be capable of making as frequent starts as the control device may demand. Motors not provided with automatic control shall be capable of making not less than 4 starts per hour.
4. Phases and Current Characteristics: Provide energy efficient squirrel-cage induction polyphase motors for 1/2 horsepower and larger, and provide capacitor-start single-phase motors for 1/3 horsepower and smaller, except 1/6 horsepower and smaller may at equipment manufacturer's option be split-phase type, unless otherwise noted.
 - a. Note: This excludes special applications of motors in 1/2 to one horsepower range where voltage limitations exist or motors which are an integral part of an assembly powered at different voltage.

- b. Coordinate current characteristics with power specified in Division 26 and with individual equipment requirements specified in other sections of Division 23, or shown on the drawings.
 - 5. Service Factor: Maximum 1.15 for 3-phase motors and maximum 1.35 for single-phase motors.
 - 6. Motor Frames: Motor frames and end bells NEMA Standard. Frames larger than 256 shall have cast iron or fabricated steel end bells and frames.
 - 7. Factory Furnished Motors: Motors smaller than 1/2 horsepower furnished as part of packaged equipment having a 460 volt main drive motor, shall include all necessary transformers and other accessories required to properly operate from the main power source with no other external connections required.
 - 8. Energy Efficiency: All motors, one horsepower or 0.75 kw and larger shall have efficiencies and power factors at full load not less than as shown in the Motor Efficiency Schedule. Efficiencies shall be determined and published in accord with NEMA MG1-12.53a and NEMA MG1-12.53b, respectively. Where local and state building codes and required or recommended energy codes exact more stringent requirements for motor efficiency and power factor, the local and state code requirements shall be adhered to.
- C. Where commercially available, motors rated greater than 5 HP shall have a power factor of not less than 90 percent under rated load conditions. Where not commercially available, power factors shall be capacitor corrected by equipment manufacturer to at least 90 percent under rated load calculations. Motors shall have 1.15 service factor at altitude.

NOMINAL FULL-LOAD EFFICIENCY
EPACT 92 (NEMA STD.MG1, TABLE 12-6C)

Horsepower Rating	ODP			TEFC		
	1200	1800	3600	1200	1800	3600
1	80.0	82.5	X	80.0	82.5	75.5
1.5	84.0	84.0	82.5	85.5	84.0	82.5
2	85.5	84.0	84.0	86.5	84.0	84.0
3	86.5	86.5	84.0	87.5	87.5	85.5
5	87.5	87.5	85.5	87.5	87.5	87.5
7.5	88.5	88.5	87.5	89.5	89.5	88.5

- D. Motor Construction:
- 1. Bearings and Shafts: All belt-connected motors, regardless of size, shall be equipped with shafts and bearings that will withstand both the normal belt pull of the drive furnished and the momentary or continuous overloads due to acceleration or incorrect belt tension.
 - 2. Bearings shall be ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is normally inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in the motor, provide bearings designed to resist the thrust loading.
 - 3. Slide Base: All belt-connected motors, regardless of size, shall be mounted using appropriately sized adjustable slide bases with dual adjusting screws to facilitate alignment and motor belt tension adjustment.

4. Enclosure Type:
 - a. Indoor where atmosphere is not excessively dirty and/or corrosive, and where satisfactorily housed or remotely located during operation: open drip-proof.
 - b. Indoor, same as above except where exposed to contact by building occupants or employees: guarded drip-proof.
 - c. Outdoor, or indoor when atmosphere is dirty and/or corrosive: Totally enclosed fan cooled (TEFC) or total enclosed non-ventilated (TENV). Where TEFC and TENV size, price, and efficiency is equal, TENV is preferred. Provide NEMA 4 rated motor and enclosure in wet environments (wash bay).
5. Overload Protection: Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping the motor at the starter.
6. Noise Rating: Provide "Quiet" rating on motors at full load, rated speed individually specified.
7. Name Plate: Provide metal nameplate on each motor, indicating full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
8. Motor Connections: Provide conduit connection boxes, and flexible power connections.

2.4 ACCESS TO MECHANICAL WORK

- A. Access Units Fire-Resistance Ratings: Where fire-resistance rating is indicated for construction penetrated by access units, provide UL listed-and-labeled units, except for units which are smaller than minimum size requiring ratings as recognized by governing authority.
- B. Provide access doors required for access to mechanical equipment, whether shown or not.
- C. Access Doors
 1. General: Where floors, walls and ceilings must be penetrated for access to mechanical work, furnish types of access doors indicated, including floor doors if any. Furnish adequate size for intended and necessary access. Furnish manufacturer's complete units, of type recommended for application in indicated substrate construction, in each case, complete with anchorages and hardware. Access doors to comply with Section 08 31 13 – Access Doors and Frames.
- D. Where valves, control devices, cleanouts and similar elements of mechanical work are located within or behind wall, ceiling or floor construction or finishes, or below grade, and are not (cannot be) provided with integral removable access plates as specified in other Division 23 sections, provide removable access plates of types and sizes needed for access requirements, as indicated. Provide manufacturer's complete units with anchorages, fasteners and standard factory-applied finishes.
 1. Wall/Ceiling Unit Construction: Except as other wise indicated, and where adaptable to substrate, provide manufacturer's standard frameless round formed stainless steel or chrome-plated brass low profile plate cover, with single exposed flush screw anchor, with bright polished finish.

2. Painted Finish: Where substrate is indicated for painted finish, provide steel units with prime-coat paint finish.

2.5 CONCRETE BASES

- A. Special inertia bases as detailed on the Mechanical Drawings shall be provided by Division 23 Mechanical with concrete work complying with provisions of Division 3 Concrete.
- B. Provide minimum 4 inch concrete pad (base) under base mounted pumps, boilers, water heaters, air handling units, floor mounted expansion tanks, glycol tanks and other floor mounted equipment.
- C. Establish the size and location of the various concrete bases required.
 1. Water heaters, air compressors and other floor mounted equipment shall have a concrete base at least 4 inches high which shall project 4 inches on all sides beyond the associated equipment.
- D. Furnish necessary anchor bolts and templates to Division 3 for locating and casting into concrete bases.

2.6 DRIP PANS

- A. Provide aluminum sheet metal drip pans with 3/4 inch drain lines below all piping crossing over all electric equipment or control devices. 3/4 inch drain lines should be run to indirect waste at nearest floor drain or plumbing receptacle.

2.7 IDENTIFICATION MATERIALS FOR PIPING AND EQUIPMENT

- A. Materials for identification shall be as follows:
 1. Metal Tags: Round brass discs, minimum 1-1/2 inch diameter with edges ground smooth. Each tag shall be punched and provided with brass chains for installation.
 2. Engraved Nameplates: Fabricate from plastic sheet stock of sufficient thickness to allow engraved lettering in contrasting color.
 3. Painted Stencils: Of size and color per ANSI A13.1 using clean cut letters and oil base paint. Paint materials shall be standard exterior type stenciling enamel, brush on or spray can form.
 4. Aluminum Tape: 1/2 inch wide aluminum tape, such as DYMO, banded in place around pipe. Imprint only one side of tab.
 - a. Acceptable Manufacturers:
 - 1) Allen Systems, Inc.
 - 2) Brady (W.H.) Co., Signmark Div.
 - 3) Industrial Safety Supply Co., Inc.
 - 4) Seton Name Plate Corp.

PART 3 - EXECUTION

3.1 EXCAVATING FOR MECHANICAL WORK

- A. General: Do not excavate for mechanical work until work is ready to proceed without delay, so that total time lapse from excavation to completion of backfilling will be minimum.

3.2 BACKFILLING

- A. Do not backfill until installed mechanical work has been tested and accepted, wherever testing is indicated.

3.3 CUTTING AND PATCHING

- A. Openings in Existing Construction:

- 1. The Division 23 contractor shall verify all openings required in the existing construction in connection with the work under Division 23 and shall then meet with and verify same with the General Contractor/Construction Manager who will assign the work to the appropriate contractor to provide all openings in the new construction of the correct size and location in walls, floors or through roofs required for the installation of the mechanical work.

- B. Cutting in Existing Construction:

- 1. Failure on the part of the Division 23 Contractor to make the above arrangements for required openings shall cause the cost of cutting and patching for the necessary openings or the installation of his work to be borne by him, either by having the cutting done by the appropriate contractor as assigned by the General Contractor or in the form of performing the required cutting himself. In either case, all patching shall be done by the appropriate finishing contractor as determined by the General Contractor; no cutting or drilling of holes shall be done without approval of the Structural Engineer/Engineer.

- C. Patching in Existing Construction:

- 1. The appropriate finishing contractor as determined by the General Contractor shall patch all openings in the existing structure. All openings made in walls, floors, or ceilings, shall be patched and made tight. All materials used in patching shall match the existing materials .

- D. The Division 23 Contractor shall pay the appropriate Finishing Contractor as determined by the General Contractor for all patching resulting from cutting to accommodate mechanical work.

3.4 HEATING SYSTEM USED FOR TEMPORARY HEAT DURING CONSTRUCTION

- A. Permanent heating system shall not be used.
- B. If for any reason the heating system has been placed into operation, it shall not be shut down except for moderate weather, and all heated areas shall be maintained at a minimum temperature of 50°F 24 hours a day. Building must be totally enclosed (No temporary barriers).
- C. When air-handling equipment is used for temporary heat, the filters shall be installed and maintained. Before building acceptance by Owner, these units shall be thoroughly cleaned (including coils, heat exchangers and duct systems) and new or cleaned filters shall be installed. This is over and above the set of filters to be provided the Owner as called for in the specifications. Coils shall be cleaned if necessary, as determined by the Structural Engineer.

- D. All systems being used for temporary heat shall become the Contractor's responsibility to maintain, and be put into first class working order before acceptance by the Owner.
- E. All guarantees that start with the use of equipment for temporary heat shall be personally extended by the contracting firm holding the prime contract for construction, so that the Owner will have his one-year guarantee from date of acceptance.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.
 - 1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated by Structural Engineer, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Place and secure anchorage devices. Use supported equipment manufacturer's 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.
 - 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 6. Use 4000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Sections.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- B. Field Welding: Comply with AWS D1.1.

3.8 TESTS

- A. General: Provide test pump, gauge, meters, other instruments, materials, labor, in connection with tests.
- B. Pressure Tests: Before testing piping systems, remove or otherwise protect from damage, control devices, air vents, and other parts, which are not designed to stand pressures used in testing piping.

3.9 EQUIPMENT IDENTIFICATION

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Equipment Identification
 - 1. Provide equipment identification for each piece of motor driven mechanical equipment. Identification shall indicate equipment tag and area served. Size of letters to be 2-1/2" min.

3.10 ADJUSTING

- A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.11 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 GENERAL

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.
- B. Extent of testing, adjusting, and balancing work required is indicated by requirements of this section; and is defined to include but is not necessarily limited to, air distribution systems, hydronic distribution systems, and associated equipment and apparatus of mechanical work. The work consists of setting speed and volume (flow) adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required by contract documents.
- C. The Mechanical Contractor shall procure the services of an independent testing, adjusting and balancing agency specializing in the testing, adjusting and balancing or environmental systems to perform the above-mentioned work. Testing, adjusting and balancing work shall be directly supervised, and the results attested by a Registered Professional Engineer. This Engineer shall represent the Testing, Adjusting and Balancing Firm in progress meetings as required, and shall be available for interpreting all material found in the balance report.
- D. Tester's Qualifications: Firm with at least 5-years of successful testing, adjusting, and balancing experience on projects with testing, adjusting and balancing requirements similar to those required for this project.
- E. NEBB Compliance: Comply with NEBB's "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems" as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.

1.2 APPROVAL OF CONTRACTOR

- A. The Mechanical Contractor shall submit the name of the Testing, Adjusting and Balancing Firm to the CDOT Representative within 30 days of contract award to ensure that the Testing, Adjusting and Balancing Firm is on the project from the outset of construction. All Testing, Adjusting and Balancing Firms desiring to offer their services for this work shall submit their qualifications to the CDOT Representative, not less than seven (7) calendar days before the bid date. Approval or disapproval will be given on each request and this action will be given in writing prior to bidding the work.
- B. Firms acceptable to do the work include but are not limited to:
 - 1. Able Balance Company
 - 2. Complete Air Balance
 - 3. Griffith Engineering Service Co.
 - 4. JPG Engineering
 - 5. TAB Services, Inc.
 - 6. Other firms may be submitted to the Architect or Owner for approval.

- C. Other firms desiring to bid the balance work shall submit a booklet of qualification which will be reviewed by the Mechanical Engineer and CDOT Representative.

1.3 SUBMITTALS

- A. Submit certified test reports, signed by Test and Balance Supervisor who performed testing, adjusting and balancing work. In addition, have report certified by Professional Engineer who is familiar with testing, adjusting and balancing work and also with project, and who is registered in jurisdiction where testing is being conducted.
- B. Include identification and types of instruments used, and their most recent calibration date with submission of final test report.
- C. Submit biographical data on Professional Engineer who is to directly supervise testing, adjusting, and balancing work.
- D. The Test and Balance Report must be submitted prior to scheduling the Project Closeout (punchlist) meeting. The Report shall be submitted to and reviewed by the CDOT representative, the certified code reviewer and the MEP engineer for review and comment. All deficient items must be corrected prior to contract closeout.

1.4 JOB CONDITIONS

- A. Do not proceed with testing, adjusting, and balancing work until work has been completed and is operable. Ensure that there is no latent residual work still to be completed.
- B. Do not proceed until work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt, and discarded building materials.
- C. Put all heating and ventilating systems and equipment into full operation and continue operation of same during each working day of testing and balancing. Preliminary testing, adjusting and balancing requirements shall be ascertained prior to the commencement of work through a review of available plans and specifications for the project. In addition, visual observations at the site during construction shall be made to determine the location of required balancing devices and that they are being installed properly for the need.
- D. Before any air balance work is done, the system shall be checked for duct leakage, assure filters are installed, see that filters are changed if they are dirty, check for correct fan rotation, equipment vibration, and check automatic dampers for proper operation. All volume control dampers and outlets shall be wide open at this time.

1.5 TEST INSTRUMENTS

- A. Utilize test instruments and equipment for testing, adjusting and balancing work required, of type precision, and capacity as recommended in the following Testing, Adjusting and Balancing standard:
 - 1. NEBB's Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.6 GUARANTEE OF WORK

- A. The Testing, Adjusting and Balancing Contractor shall guarantee the tests and balance for a period of 90 days from date of final acceptance of the test and balance report. During this period, the Testing, Adjusting and Balancing Contractor shall make personnel available at no cost to the Owner to correct deficiencies in the balance.

1.7 RETAINAGE

- A. Contract payment retainage may be withheld against the Mechanical Contractor until the final completion of this section of work has been demonstrated by the submission of the Testing, Adjusting and Balancing report and an evaluation of its contents has been made by the Engineer.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

- A. Except as otherwise indicated, use same products as used by original Installer for patching holes in insulation, duct work and housings which have been cut or drilled for test purposes, including access for test instruments, attaching jigs, and similar purposes.
 - 1. At Tester's option, plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

PART 3 - EXECUTION

3.1 GENERAL

- A. Examine installed work and conditions under which testing is to be done to ensure that work has been completed, cleaned, and is operable. Do not proceed with testing, adjusting and balancing work until unsatisfactory conditions have been corrected in manner acceptable to Tester.
- B. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards.
- C. Test, adjust and balance system during winter season for heating systems, including at least period of operation at outside conditions within 5°F (3°C) wet bulb temperature of maximum summer design condition, and within 10°F (6°C) dry bulb temperature of minimum winter design condition. When seasonal operation does not permit measuring final temperatures, then take final temperature reading when seasonal operation does permit.
- D. Balance all air flows to terminals within + 10% to -5% of design flow quantities. Measure and record the following data.
- E. Air Balance: Air supply, return and exhaust systems with air quantities for each air device; air handling units including supply, return, mixed, and outside temperatures and fan data including CFM, static pressure, fan RPM, motor running and full load amperage before and after final balance. Air diffusion patterns shall be set to minimize objectionable drafts and noise.
- F. The supply, return and exhaust fan static pressure shall be set by the balancing firm and the control contractor if the systems have fan volume control dampers. The duct static shall be

confirmed both through the instrumentation installed on the job and by the balancing contractor. The system shall be tested in all operation modes (full return air, full outside air, modulated damper position, full cooling) with the design diversity and full cooling with no design diversity. Amperages shall be recorded in all modes. The fan speed resulting in satisfactory system performance shall be determined at full design delivery. Inlet or outlet fan volume control dampers shall be in the wide open position and one path representing the greatest resistance to flow shall be fully open and unobstructed.

- G. Final adjustments shall include but not be limited to the following:

ITEM	ADJUSTMENT
All Fans: Direct Drive	Direct Drive RPM with speed taps. Set fan speed on tap which most closely approaches design CFM. Report tap setting on equipment data sheet as high, medium or low. RPM with speed control rheostat. Set output of fan at design CFM by adjusting the SCR. After adjustment, check fans ability to restart after powering down. Increase setting if required for proper starting.

3.2 GENERAL PROCEDURES

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or ASHRAE 11 or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

3.3 REPORT OF WORK

- B. The Testing, Adjusting and Balancing Contractor shall submit one (1) bound and one electronic copy of the final test and balance report at least 15 days prior to the Mechanical Contractor's request for final inspection. All data shall be recorded on applicable reporting forms. The report shall include all operating data as listed in sections above, a list of all equipment used in the testing, adjusting and balancing work, and shall be signed by the supervising engineer and affixed with his certification seal. Final acceptance of this project will not take place until a satisfactory report is received.
- C. When deemed necessary by the Mechanical Engineer, the balancing firm shall run temperature and/or humidity recordings and shall read all of the reported quantities in the presence of the engineer for verification purposes.
- D. When all balancing is done and all dampers are set, all test holes shall be plugged and all dampers shall be marked. The following information shall be recorded in the final report: Design inlet or outlet size, actual inlet or outlet size, design CFM and velocity through the orifice, for each terminal in the system.
- E. The pilot tube traverse method for determining CFM shall be used and recorded wherever possible.

3.4 BALANCING REPORT

- A. After all balancing is complete and all coordination with the contractor and the engineer is complete, the balancing firm shall furnish a bound report which shall contain the following information:

1. RPM, drive sheave information (as installed and as changed), fan nameplate information, motor nameplate information, and amperage and voltage to all motors (in all operating modes).
2. Static pressure across all components of the system.
3. Required and final balanced CFM at each system terminal. Include the terminal size, reading orifice size, and velocities read to attain the CFM.
4. Pump and motor nameplate information, amperage and voltage to all motors, pressure drop across all system terminals, pressure rise across the pump in psi and feet of head.
5. Thermal protection for all motors shall be recorded. Starter 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 shall be recorded. If the starters were furnished by the mechanical contractor, the heaters shall be changed to the correct size and so noted in the report. If the starters were furnished by the electrical contractor, the correct heater sizes shall be noted in the report and the electrical contractor shall be advised.
6. The report shall include a sheet which shall report the method of balance, project altitude, all correction factors used in the calculations.

3.5 OWNERS INSTRUCTIONS

- A. Upon final completion of the job, the Mechanical Contractor shall schedule time with the CDOT representative and Mechanical Engineer to review each component of the mechanical system and to instruct the Owner's representative on proper operation and maintenance of the system. The Mechanical Contractor shall be present to review all temperature control systems.
- B. Patch holes in insulation, ductwork, and housings, which have been cut or drilled for test purposes, in manner recommended by original Installer.
- C. Mark equipment settings, including damper control position, valve indicators, fan speed control levers, and similar controls and devices, to show final settings at completion of testing, adjusting and balancing work. Provide markings with paint or other suitable permanent identification materials.
- D. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced; including, where necessary, modifications which exceed requirements of contract documents for mechanical work.
- E. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

END OF SECTION

SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 GENERAL

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.
- B. Approved Equipment Manufacturers: Trane, Mitusbishi, Honeywell, Johnson Service Co., Penn, Powers or Robertshaw.
- C. Temperature control system shall be of the electric or electronic type, with electric or electronic components to comprise a complete system, furnished and installed, by Mechanical Contractor, connected by the Electrical Contractor, put into operation and adjusted under operating conditions, and carefully coordinated with Mechanical and Electrical Contractors.
- D. System shall include all valves, thermostats, motorized dampers, damper motors, controllers and other control devices shown on drawings or as specified. All control devices shall be connected complete to perform the functions indicated, so as to operate in the required sequence.
- E. All temperature control bulbs and thermometers sensing air temperature shall be properly located to best compensate for possible stratification of air in the system.
- F. All automatic control dampers, unless otherwise specified, shall be furnished and installed by Mechanical Contractor.

1.2 SUBMITTAL

- A. Submit for approval two (2) sets or one electronic set of information including descriptive literature, control wiring diagrams, damper schedules.
- B. After approval, this Contractor shall furnish a sufficient quantity of drawings to all crafts involved and shall make certain they are familiar with all work they must perform in conjunction with the control system.

1.3 GUARANTEE

- A. The control system shall be guaranteed by the manufacturer for a period of one (1) year from date of acceptance by the owner. During this period, the manufacturer shall furnish all labor and material necessary to the satisfaction of the Owner, assuming such material and workmanship is necessary because of original defects.

PART 2 - PRODUCTS

2.1 CONTROL COMPONENTS

- A. Controllers: Thermostats and other controllers shall be solid state devices providing full proportional control, either direct or reverse action, or both as required for sequential control. Control supply voltage shall normally be 24 volt, and control signal voltage 0-10 volt DC.

2.2 THERMOSTATS

- A. Thermostats shall be complete with automatic heating-cooling changeover, night setback control, and "on-off" fan switch. U.L. Listed.
- B. Automatic changeover thermostats shall be Honeywell T7300A1005 with Q7300B1008 sub-base, or equal. Alternate Product: Honeywell RTH8500D.

PART 3 - EXECUTION

3.1 WIRING

- A. All control wiring and conduit shall be installed by the Electrical Contractor. All costs of controls, wiring, conduit, and associated labor shall be included in electrical bid, except as otherwise noted.
- B. Control wiring, conduit, fittings, etc. shall be furnished in accord with requirements of electrical section of the specifications. All necessary control wiring and interlocks not shown on electrical drawings to be provided by Electrical Contractor.
- C. All electric wiring shall be performed in accordance with the National Electrical Code and local standards.

3.2 THERMOSTATS

- A. Thermostats to be mounted a maximum of 48 inches above the floor in compliance with ADA and ANSI requirements.

END OF SECTION

SECTION 23 30 00
HVAC AIR DISTRIBUTION

PART 1 - GENERAL

1.1 GENERAL

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.
- B. Set all equipment and make duct connections. Provide adequate access to controls, valves, piping connections, filters motors, drives, etc. as necessary.

1.2 DESCRIPTION OF THE WORK

- A. Types of air distribution components in this section include the following
 1. Grilles, Registers and Diffusers

1.3 QUALITY ASSURANCE

- A. Codes and Standards:
 1. SMACNA Standards: Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork.
 2. ASHRAE Standards: Comply with ASHRAE Handbook, Equipment Volume, Chapter 1, "Duct Construction," for fabrication and installation of metal ductwork.
 3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" and NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems."

1.4 SUBMITTALS

- A. Shop Drawings: Submit scaled layout drawings of metal ductwork and fittings including, but not limited to, duct sizes, locations, elevations, and slopes of horizontal runs, wall and floor penetrations, and connections. Show interface and spatial relationship between ductwork and proximate equipment. Show modifications of indicated requirements, made to conform to local shop practice, and how those modifications ensure that free area, materials, and rigidity are not reduced. Submit for the following products in accordance with Section 01 33 00:
 1. Grilles, Registers and Diffusers

PART 2 - PRODUCTS

2.1 GRILLES, REGISTERS, DIFFUSERS

- A. Approved manufacturers: Krueger, Price, Titus
- B. Material to be Steel with powder coat finish
- C. Manual Volume Dampers
- D. Types: Supply
 - 1. Lay-in or Surface Mount:
 - a. Frame: 12 inch x 12 inch or 24 inch x 24 inches
 - b. Models: Krueger: 6200; Price: PDC / SCD; Titus: PCS
 - 2. Supply Grille: Ceiling or Sidewall
 - a. Frame: 8 inch x 8 inch or 12 inch x 8 inch
 - b. Models: Krueger: 880/5880; Price: 520 / 620; Titus: 300R / 300F
- E. Types: Return and Exhaust
 - 1. Lay-In
 - a. Frame: 24 inch x 24 inch
 - b. Models: Krueger: 6490; Price: PDDR; Titus: PAR
 - 2. Return Grilles: Ceiling or Sidewall
 - a. Frame: 6 inch x 6 inch, 12 inch x 6 inch, 12 inch x 10 inch, 16 inch x 6 inch, or 24 inch x 12 inch
 - b. Models: Krueger: S80; Price: 530; Titus: 350R

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION:

- A. All equipment shall be installed complete with bases, supports, mounting frames, piping connections, vents, etc., as required. Installation, shop drawings, etc., of all equipment shall be coordinated with other trades.
- B. All air moving equipment is to be rated, selected and adjusted to deliver air quantities shown at site elevation. Fan speeds are to be changed as required to deliver CFM shown and new sheaves furnished and installed if necessary.

END OF SECTION

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SECTION 23 50 00
CENTRAL HEATING EQUIPMENT

PART 1 - GENERAL

1.1 GENERAL

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.
- B. Provide all items, materials, articles or methods listed or scheduled on drawings or herein specified, including all labor, materials, equipment and incidentals necessary and required for their completion.
- C. Related Section includes
 - 1. 23 81 26 Split System Air Conditioning

1.2 SUBMITTALS

- A. Product Data: Submit for the following in accordance with Section 01 33 00.
 - 1. Gas-Fired, Low-Intensity, Radiant Tube System
 - 2. Baseboard Heaters
 - 3. Heat Pumps (see section 23 81 26 Split System Air conditioning)
 - 4. Gas-Fired Boilers
- B. Operating Instructions and Maintenance Data: Submit for the following in accordance with Section 01 78 23.
 - 1. Gas-Fired, Low-Intensity, Radiant Tube System
 - 2. Baseboard Heaters
 - 3. Heat Pumps (see section 23 81 26 Split System Air conditioning)
- C. Refer to Project-Specific "Submittal Log" provided by Owner at Pre-Bid Meeting.

PART 2 - PRODUCTS

2.1 GAS-FIRED (VACUUM VENTED ALLOWED), LOW INTENSITY, RADIANT TUBE SYSTEM

- A. Approved manufacturers: Ambi-Rad or CDOT-approved equals listed in A.2. below; any other products must be approved by CDOT PRIOR to Addendum # 2 Question Due Date, as set forth in Addendum # 1.
 - 1. Ambi-Rad Radiant Tube Heater Model VPLUS 100/S30 for VSF and VCLUS 100/S30 at wash bay (fan and motor enclosed). 4 inch Individual wall venting per codes. 4 inch Outside Air through the wall installation per Manufacturer's Manual. Heaters in wash bay to be approved for wet environment.

2. Other acceptable manufacturers: Solaronics, Detroit Reverberay products meeting these specifications.

B. Heater parameters/specifications:

1. Gas fired infra-red tube heaters shall be furnished and installed in accordance with governing codes and as shown per drawings(s) provided.
2. Infra-red tube heaters shall be design certified by the CSA International (CSA) and comply with current Occupational Safety and Health Act (OSHA) requirements.
3. The supplier shall provide a manufacturer's published warranty covering the heater's combustion and radiant emitter tube assembly for a minimum period of five (5) years, and all components utilized in the heater control assembly for a period of one (1) year.
4. Infra-red tube heaters shall be designed to operate without adjustments when burning propane or natural gas.
5. The infra-red tube heaters shall be designed such that outside combustion air is supplied without the use of additional supply fans. An air intake collar shall be supplied as part of the burner control assembly to accept a 4 inch O.D. supply duct.

C. Definitions:

1. System shall be fired on propane or natural gas. System shall operate to preclude the possibility of gases escaping into the building. System is to be the low intensity type to assure even heat distribution.
2. A system shall consist of a number of burner units, (vacuum pump optional), radiant tubing, reflectors and a control system.

D. Standards:

1. Each burner shall have a name plate affixed that bears the seal of the IAS.

E. Equipment:

1. Pre-Mix, Burner Units:
 - a. Each burner shall consist of a heavy duty burner head, pre-wired gas controls, transformer, direct spark and 3 try ignition (DSI). Combustion air filter, optional.
 - b. Where utilized, tandem burners shall be designed for firing in tandem without adverse effects from combustion gases from upstream burners.
 - c. Combustion chamber shall include a sight port, for viewing the flame, shall be factory installed for easy viewing from the floor.
 - d. Design firing rates shall be per drawings. To assure even heat distribution, BTU size shall meet the size indicated on the plans. The system shall employ the same number of firing units as indicated on the plans. Higher rated burners are not acceptable.
 - e. To assure maximum combustion efficiency, burner shall be the Pre - Mix burner type that provides a constant proportion of fuel gas to filtered combustion air.
 - f. Where combustion air is susceptible to contamination, the combustion air for the main burner shall pass through a dust and dirt filter, insuring that dirt will not enter into burner and/or control housing.
 - g. Burner cabinet shall be made of type 304 or 304L stainless steel.

2. Burner Control:
 - a. All burners shall be factory wired for 110 volts, with direct spark, 3-try ignition (DSI).
 - b. To assure a high degree of fail safe operation, the design shall preclude main flow of gas if any or all of the following abnormal conditions occur.
 - 1) Vacuum pump or blower motor fails
 - 2) Power fails (gas valves in burners close in safe position).
3. Radiant Tubing/Pipe - Heat Exchanger:
 - a. Radiant branch tubing shall be 4 inch, 12 gauge black steel.
 - b. Tail pipe branch tubing shall be 4inch, aluminized 406 stainless steel tubing
 - c. Hanging of the system must be in accordance with the CSA/IAS manufacturer recommendations, local codes and be to professional trade standards.
 - d. Tube couplers shall be made of stainless steel.
4. Reflectors:
 - a. Reflectors shall be a minimum of 24 gauge polished, type 409 stainless steel or mil finished aluminum.
 - b. To assure a minimum of convection loss, mitered reflector joints shall be used at elbows.
 - c. Reflectors shall be of the "deep dish" design, effectively "wrapping" three sides of the tubing.
 - d. Reflector supports shall be securely tightened around the tubing. Every other support shall secure the reflectors together with a fastener (tin clips not acceptable).
 - e. Side Reflectors shall be the types that are one piece with the top reflector, to assure no separation in high winds. Separate side reflectors are not acceptable.
5. Vacuum Pump (optional):
 - a. The system shall vent all products of combustion by means of a non-corrosive, cast aluminum vacuum pump.
 - b. Vacuum pump shall be equipped with a 120 volt, 1 PH motor. The motor shall be a type approved for dust and wet environments. This motor shall have thermal overload protection, and ball bearings. Motor must have the same rotation as indicated on the fan scroll.
 - c. The vacuum pump shall be acoustically isolated from the system with a flexible connector that has a minimum temperature rating of 350 degrees F. The vacuum motor shall be secured to the frame by means of rubber mounts.
6. System Controls:
 - a. Pre wired control panel shall provide the following features:
 - 1) Pre-Purge of tubing on an adjustable timer.
 - 2) Post-purge of tubing on an adjustable timer.
 - 3) Indicator light for "Fan Run".
 - 4) Indicator light for "Mains On."
 - 5) Indicator Light for Each Individual Burner - "Burner On."

- 7. System Warranty:
 - a. Manufacturer shall provide the following warranty:
 - 1) 10 years all stainless steel components
 - 2) 5 years all non-stainless steel components
 - 3) 3 years all electrical components

2.2 HEAT PUMP

- A. Refer to Section 23 81 26 Split System Air Conditioning for heat pump details.

2.3 BASEBOARD HEATERS

- A. Refer to drawings for baseboard heater performance and physical requirements.
- B. Baseboard heater shall be controlled by a wall mounted thermostat that is mounted at ADA height. Temperature control at the unit is not permitted.

2.4 GAS-FIRED BOILERS

- A. Refer to drawings for boiler performance specification and piping diagrams.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. All equipment shall be installed complete with bases, supports, mounting frames, piping connections, vents, etc., as required. Installation, shop drawings, etc., of all equipment shall be coordinated with other trades.
- B. Radiant tube heater exhaust pipes shall be sloped at ¼ inch per foot in accordance with manufacturer recommendations.

3.2 ELECTRICAL WIRING

- A. All the wiring in connection with the automatic temperature control system, except wiring carrying the full load current, shall be furnished under this section as required to make a complete and operating temperature control system. All interlock wiring specified under this Section shall also be provided. All electrical wiring shall be installed in accordance with prevailing National and Local Codes (see Division 26 on Electrical Work for Coordination required) and shall be stranded continuous wire run in conduit.
- B. Items to be controlled:
 - 1. Baseboard Heaters
 - 2. Gas-Fired, Low-Intensity Radiant Tube System
 - 3. Heat Pump

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wire and connectors
 - 2. Supporting devices for electrical components
 - 3. Electricity-metering components
 - 4. Service Entrance CT cabinet

 - 5. Cutting and patching for electrical construction
 - 6. Touchup painting
- B. Provide complete raceway systems for conductors unless otherwise specified.
- C. Provide complete system of conductors as required for raceway systems. Where quantities of conductors are not specifically indicated, provide necessary number to maintain circuits and function.
- D. Provide metal boxes for use as outlet boxes, pull boxes, or junction boxes. Boxes to include pressed steel boxes, masonry boxes, and weatherproof cast steel or aluminum boxes.
- E. Provide support for conduit, wireway, junction boxes, pull boxes and related equipment.
- F. Provide fire sealing of holes and voids through fire rated barriers.

1.3 DESIGN RESPONSIBILITY

- A. Wire and cable sizes indicated are copper. Aluminum may be used for service and feeder conductors sized #2 AWG and larger, unless otherwise indicated. Should aluminum be used, the Contractor is responsible for determining revised:
 - 1. Conductor sizes to achieve the same ampacity and voltage drop as copper sizes indicated.
 - 2. Raceway boxes and equipment sizes and locations
 - 3. Short circuit current values and AIC ratings of equipment
- B. Contractor to resolve to the satisfaction of CDOT and the Engineer problems that are a direct result of the use of aluminum in lieu of copper.

1.4 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RNC: Rigid nonmetallic conduit.

1.5 SUBMITTALS

- A. Product Data:
 - 1. For electricity-metering equipment.
 - 2. Conduit, fittings and supports
 - 3. Boxes
 - 4. Fire Seals where applicable
- B. Shop Drawings: Dimensioned plans and sections or elevation layouts of electricity-metering equipment.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- D. Should aluminum wire and cables be used, provide a revised one-line and partial plans indicating revised conductor, raceways, box, equipment size, locations, fault calculations and AIC ratings of equipment.

1.6 QUALITY ASSURANCE

- A. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to metallic and nonmetallic electrical raceway.
- B. UL labels: Provide electrical raceways, boxes, conductors, and connectors which have been approved, listed and labeled by UL.
- C. ANSI/ASTM Compliance: Provide electrical raceways and conductors which comply with applicable portions of ANSI/ASTM standards for construction of raceways and conductors.
- D. NEMA/ICEA Compliance: Provide conductors which comply with applicable portions of NEMA/ICEA standards pertaining to material, construction, and testing of conductors.
- E. Federal Specification: Provide electrical raceways and conductors which meet applicable portions of Federal Specification.

- F. 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.
- G. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section 08 31 13 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid metal conduit shall be steel, galvanized inside and outside. Factory made threads shall be full cut and galvanized after threading. The conduit shall be UL listed and shall meet the requirements of UL 6 and ANSI C80.1.
- B. Electrical metallic tubing shall be hot-dipped galvanized or electro-galvanized steel with an inner coating to protect cables and aid pulling. The conduit shall be UL listed and shall meet the requirements of UL 797 and ANSI C80.3.
- C. Flexible metal conduit shall be composed of one spirally wound continuous strip of interlocked galvanized steel. The conduit shall conform to Federal Specification WW-C- 566C and shall meet the requirements of UL 1.
- D. Liquid tight flexible metal conduit shall be galvanized steel with an oil and sunlight resistant polyvinyl chloride jacket bonded or extruded onto the exterior. Liquid tight flexible metal conduit shall be approved for grounding. Liquid tight flexible metal conduit shall meet UL Standard For Safety, UL 360.

- E. Rigid nonmetallic conduit, unless otherwise noted, shall be Schedule [40] [80] rigid plastic, PVC rated for use with 90 degree C wire and shall be UL listed and conform to UL 651 and NEMA TC-2.
- F. Rigid nonmetallic type EB-20 conduit shall be ETL listed, tested to UL-651-A, and meet the requirements of NEMA TC-6 and ASTM F-512.

2.2 CONDUIT FITTINGS

- A. Fittings for rigid metal conduit shall be galvanized or cadmium plated. Fittings shall be threaded. Couplings shall be of galvanized steel. Locknuts and bushings shall be steel or malleable iron. Bushings shall have nylon insulated throat.
- B. Connectors, couplings and combination couplings for EMT shall be steel set screw or steel compression type. Insulated throat connectors shall be used for sizes 1 inch (DN27) and smaller. Uninsulated connectors with insulated bushing shall be used for sizes larger than 1 inch (DN27).
- C. Fittings for flexible metal conduit and liquid tight flexible metal conduit shall be of a type specifically designed for the purpose.
- D. Fittings for rigid nonmetallic conduits shall be of same material and manufacturer as conduit. Non-metallic fittings shall be UL listed and conform to UL 514.
- E. Expansion fittings across structural joints shall be of a design to compensate for expansion and contraction and shall be sealed to prevent entrance of water or moisture. Expansion fittings shall be approved for grounding duty.
- F. Adapters for joints between PVC and steel conduits shall be UL listed Carlon E942 and E943 series.

2.3 WIRE AND CABLE

- A. Conductors shall be new and unused. Wire and cable shall be copper single conductor type with 600 V insulation, unless otherwise noted. Conductor shall be soft annealed Class B, per ASTM B-3 for solid wire and ASTM B-8 for stranded wire. Conductors shall be minimum 98% conductive.
- B. Aluminum conductors shall be an aluminum alloy that is listed or labeled by UL as "component aluminum-wire stock (conductor material)." Type EC/1350 aluminum is not acceptable. Conductors shall be "Stabiloy" as manufactured by Alcan.
- C. Number 10 AWG and smaller wire except for motor circuits shall be solid with Type THHN, or THWN insulation. Larger wire and motor circuit feeders shall be stranded with Type THHN, or THWN insulation. Conductors for service entrance use or where used underground shall be type XHHW only. Grounding conductors shall be copper.
- D. Insulation shall be flame retardant, heat resistant polyvinyl chloride (PVC), ethylene propylene (EP) or polyethylene (PE) with minimum insulation thicknesses per table 310-13 of the NEC. The insulation shall conform to the requirements of UL 83 ICEA S-68-516 for EP, ICEA S-61-402 for PVC and PE.

- E. Type THWN or THHN wire and cable shall have a outer nylon jacket conforming to UL-83. Cables shall be manufactured to meet the standards of Insulated Cable Engineer's Association (ICEA).
- F. MC Cable shall be UL listed, and consist of color-coded insulated conductors wrapped surrounded with a moisture resistant tape and enclosed in a galvanized steel interlocked cladding. Each cable shall contain a full sized ground wire.
- G. NM cable shall be UL listed, and consist of color-coded thermoplastic insulated conductors enclosed in a polyvinylchloride plastic overall jacket. Each cable shall contain a full sized ground wire.
- H. All homeruns shall be in EMT. Electrical contractor shall obtain written approval from design engineer for the use of type MC and type AC cabling. Type MC and AC cable shall be permitted for branch circuit wiring in approved locations only and installed per the latest adopted edition of the National Electrical Code.
- I. Wire-pulling lubricant shall be equal to Ideal "Aqua Gel CW" or Dow Corning compound #7.

2.4 CONNECTORS AND SPLICES

- A. For solid wire size #10 and smaller, "Scotchlok" insulated twist-on connectors or compression type, 600 V insulated or acceptable substitution.
- B. For stranded wire, "Burdny Hydent" hydraulic compression type, taped to 600 V insulation level.

2.5 PULL AND JUNCTION BOXES

- A. Provide code gauge sheet metal boxes with suitable covers, trims, etc. Boxes to be sized, per the NEC, by number and size of conduits and conductors, unless otherwise noted.

2.6 OUTLET BOXES

- A. Boxes shall be zinc or cadmium-plated code gauge pressed steel and of the knock-out type. Depth may vary to suit requirements of location.
- B. Boxes shall accommodate devices to be installed and shall be sized as required by the NEC for number and size of conduits and conductors entering and leaving. Round boxes shall not be permitted, except where specifically called for.
- C. Special oversized outlet boxes shall be code gauge steel and of the knock-out type. Boxes shall have screw mounted covers for surface or flush mounting. Boxes shall be sized as indicated or as required by the National Electrical Code. Special outlet boxes shall accommodate the equipment served.
- D. Weatherproof boxes shall be cast aluminum with threaded hubs. Boxes shall have screw mounted, gasketed covers.

2.7 SUPPORTS

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.
 - 1. Channel Thickness: Selected to suit structural loading.
 - 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- G. Expansion Anchors: Carbon-steel wedge or sleeve type.
- H. Toggle Bolts: All-steel springhead type.

2.8 CONDUIT SUPPORTS

- A. Single Runs: Galvanized malleable-iron conduit straps for surface mounting or 3/8 inch (0.95 cm) threaded rod with steel one bolt conduit clamps for all suspended runs.
- B. Multiple Runs: Channel support for surface mounting or trapeze style hangers of 1-5/8 inches by 1-5/8 inches (4.13 cm by 4.13 cm) galvanized steel channels, supported by 3/8 inch (0.95 cm) threaded rod for all suspended runs. Size hangers to allow for 25 percent additional conduits.
- C. Supports and hardware shall be galvanized steel, except that high carbon spring steel supports may be used in steel stud walls to support horizontal and vertical conduit up to 3/4 inch (DN21).
- D. Perforated plumbing tape is not permitted in any support application
- E. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
- F. Conductors, Larger than No. 10 AWG: Stranded copper.
- G. Insulation: Thermoplastic, rated at 75 deg C minimum.
- H. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

2.9 ANCHOR METHODS

- A. Hollow Masonry: Toggle bolts or spider type expansion anchors.

- B. Solid Masonry (excluding concrete): Steel expansion bolts.
- C. New Concrete: Preset inserts with machine screws and bolts. Existing Concrete: Steel expansion bolts.
- D. Wood Surfaces: Wood screws.
- E. Steel: Welded threaded studs or galvanized steel clamps.
- F. Light Steel: Sheet Metal Screws

2.10 FIRE SEALS

- A. Fire seals for walls and floors shall be an intumescent material capable of expanding to fill voids when exposed to temperatures beginning at 250 degree F (121 degree C). The seal system shall be U.L. classified and have ICBO, BOCA, and SBCC ratings to 3 hours. The seal system fire rating shall equal or exceed the fire rating of the penetrated surface to comply with NEC Section 300-21.

2.11 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING

- A. Current-Transformer Cabinets: Comply with requirements of electrical power utility company.
- B. Meter Sockets: Comply with requirements of electrical power utility company.
 1. Housing: NEMA 250, Type 3R enclosure.

2.12 CONCRETE BASES

- A. Concrete Forms and Reinforcement Materials: As specified in Section 03 30 00 "Cast-in-Place Concrete."
- B. Concrete: 3000-psi (20.7-MPa), 28-day compressive strength as specified in Section 03 30 00 "Cast-in-Place Concrete."

2.13 TOUCHUP PAINT

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 09 90 00 "Painting and Coating."
 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 3. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
 4. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
 5. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 TYPES OF CONDUIT INSTALLATION

- A. Buried raceways, except where concrete encased, shall be rigid metal conduit or rigid nonmetallic conduit.
- B. Raceways embedded in concrete slabs at or below grade level shall be rigid nonmetallic conduit, except in classified hazardous areas.
- C. Where rigid nonmetallic conduit is used for buried or encased and buried conduit runs, use a minimum of 5 feet (1.52 m) of rigid metallic conduit at foundation penetrations.
- D. Raceways embedded in concrete slabs above grade level shall be rigid metal conduit, electrical metallic tubing, or rigid nonmetallic conduit.
- E. Hazardous areas raceways shall be rigid metal conduit only.
- F. Raceways outdoors, and in locations subject to mechanical injury shall be rigid metal conduit.
- G. Motor, vibrating equipment, and rooftop mounted heating, ventilating, and air conditioning equipment connections shall be made with PVC jacketed liquid tight flexible metallic conduit for the last 2 feet (0.61 m) with liquid tight connectors. Similar equipment connections in environmental air plenums shall be made with flexible metal conduit.
- H. Raceways in concealed spaces of office areas are permitted to be Flexible Metal Conduit.
- I. Raceways in other areas shall be electrical metallic tubing unless otherwise noted.

3.2 CONDUIT SIZES

- A. Minimum size allowable for galvanized rigid metal conduit or EMT shall be 3/4 inch (DN21).
- B. Minimum size allowable for liquid tight flexible metal conduit shall be 3/4 inch (DN21).
- C. Minimum size allowable for flexible metal conduit shall be 3/4 inch (DN21) except for luminaire and control wiring for which 3/8 inch shall be allowed

3.3 CONDUIT INSTALLATION

- A. Unless noted as aluminum, conductor and conduit sizes shown on Drawings are based on the use of copper conductors.
- B. Wire and cable shall be run in metal raceways, except where nonmetallic raceways have been specifically approved.
- C. Conduit shall be run parallel to walls, ceilings, and building lines wherever possible.
- D. Conduit shall be installed in finished walls and above suspended ceilings. Conduit routed above suspended ceilings shall be surface mounted to the structural ceiling. When above suspended ceilings, route conduits above suspended lay-in ceiling instead of suspended hard ceilings wherever possible. Coordinate the routing of all other conduit with the Architect prior to rough-in.

- E. Where flexible metal conduit is used for equipment connections or other special (approved) situations, ground continuity shall be provided in accordance with the NEC. Liquid tight flexible metal conduit shall be used for flexible equipment connections in damp and wet areas except where installed in environmental air plenums where flexible metal conduit shall be used.
- F. Do not cut, notch or drill structural framing members for the installation of conduit without the Architect's approval in each case.
- G. Where rigid metal conduit enters a box, fitting or device through a knockout, double locknuts and an insulated metallic bushing shall be used. EMT shall terminate at knockouts with an insulated throat fitting and one locknut. Connectors shall be made up tight to ensure electrical continuity of the raceway system. Provide grounding bushings at each junction box, pull box, or enclosure as required by the NEC.
- H. Rigid metal conduit shall be reamed after threads are cut. Joints shall be cut square and shall butt solidly into couplings. Running threads shall not be permitted. Cut ends of EMT shall also be reamed.
- I. Bends in rigid metal conduit and EMT runs larger than 1-1/4 inches (DN35) shall be factory-made elbows unless otherwise specifically approved. Bends in 1-1/4 inch (DN35) and 1 inch (DN27) runs shall be made in an approved bending machine or factory made. Hickey bends shall not be permitted in conduits larger than 3/4 inch (DN21). Field bends shall be in accordance with the requirements of the NEC.
- J. Conduits run in masonry shall be placed at least 1 inch (DN27) from the surface.
- K. Install expansion fittings where conduit crosses an expansion joint in structure or is in an environment where temperature changes combined with conduit run length produce expansion or contraction stress on the installation. Ends of conduit shall be provided with insulated grounding bushings. Copper ground rings or a flexible bonding jumper, equal to at least three times the nominal width of the joint, shall be provided to insure a continuous ground between conduit and fitting.
- L. Provide separate code-sized ground conductor for each run of conduit. Conduit shall be sized to accommodate ground conductor.
- M. Install under floor conduit in floor slab.
- N. Install buried or encased and buried conduits in accordance with Sections 300-5 of the NEC. Where possible, exterior conduits shall be buried at minimum of 30 inches (76.2 cm) below grade or as indicated on the Drawings. Contractor shall verify with Architect, prior to installation, exterior buried conduits not buried a minimum of 30 inches (76.2 cm) below grade. Slope conduit to drainage point at least 4 inches (10.16 cm) per 100 feet (30.48 m).
- O. Adjustments in line and grade for direct buried or encased and buried conduits shall be via long sweeps with minimum of 48 inch (121.92 cm) radius. Route such conduits below existing or new gas lines.
- P. Multiple runs of conduit below grade under slab shall be installed in trenches backfilled with sand. Each layer of conduit shall be installed separately, backfilled with sand, and compacted to the depth needed to provide continuous support for the next layer of conduit. Sand shall be spread evenly and compacted to grade level for coverage of the final layer of conduit. Offset joints to maintain uniform spacing between conduit.

- Q. Direct buried or encased and buried conduits shall first be swabbed out and then shall be capable of passing a rigid ball 1/4 inch (0.64 cm) smaller than the inside diameter of conduit. Such conduits for future use shall be capped to prevent entry of dirt and debris.
- R. Provide roof jacks for waterproofing conduit penetrations of roof. Conduit routing and mounting on roofs shall be coordinated with the CDOT Representative. Unless otherwise indicated or required, conduit shall be mounted 12 inches (30.48 cm) above the finished surface of flat roofs on redwood or treated wood standoffs. Conduits shall be permanently attached to standoffs. Standoffs shall rest freely on roof without being anchored to roof surface.
- S. Joints for rigid nonmetallic conduit shall be solvent cemented in strict accordance with manufacturer's recommendations.
- T. Elbows from below grade conduit to above grade shall be PVC jacketed rigid metal conduit and shall extend 6 inches (15.24 cm) above grade or finished floor. PVC corrosion resistant tape shall not be permitted.
- U. Conduit extending from below grade to above grade, or conduit stubbing out of floors, shall be rigid metal conduit for a minimum of 12 inches (30.48 cm) above grade or finished floor.
- V. Wherever conduits enter structure through foundation below ground level, grout around conduit with waterproof grout or install wall and floor entrance seals. Seals shall be OZ/Gedney WS series for new construction and OZ/Gedney CSM series for existing structures.
- W. Conduits which pierce air tight spaces or plenums shall be sealed to prevent leakage.
- X. Care shall be taken to avoid placing conduits where they shall be subjected to excessive heat. Locate conduits a minimum of 12 inches (30.48 cm) from flues, steam lines, hot water lines, etc.
- Y. Conduit ends shall be capped using standard capped bushings to prevent entrance of foreign materials during and after construction. When conduit installation is not in progress close open ends of conduit with temporary plugs or caps.
- Z. Clean conduits prior to installation of wires. Install a nylon pulling line in each conduits run assembly or after completion of each conduit run assembly for installation of wires or for future use.
- AA. Wire shall not be installed until work which might cause damage to conduit or wire has been completed.
- BB. PVC-coated rigid metal conduit shall be installed by a manufacturer-certified installer.

3.4 ELECTRICAL EQUIPMENT INSTALLATION

- A. **Headroom Maintenance:** If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.
- B. **Materials and Components:** Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. **Equipment:** Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. **Right of Way:** Give to raceways and piping systems installed at a required slope.

3.5 WIRE AND CABLE INSTALLATION

- A. Minimum wire size for lighting and power circuits shall be #12. Signal and control circuits may use #14 except as noted. Wiring shall be installed in conduit, unless otherwise noted.
- B. Unless otherwise indicated, the maximum number of branch circuits allowed in each conduit shall be three. In such cases, the branch circuits shall also be of different phases.
- C. Unless otherwise indicated or required, the following schedule shall be adhered to for conductor sizes:

CIRCUIT OVERCURRENT DEVICE RATING

COPPER CONDUCTOR SIZES

20A or Less	#12 AWG
30 A	#10 AWG
40 A	#8 AWG
50 A	#6 AWG
60 A	#4 AWG
70 A	#4 AWG
80 A	#3 AWG
90 A	#2 AWG
100 A	#1 AWG

- D. To limit voltage drop, 120 V branch circuits with length from panel to first outlet exceeding 75 feet (22.86 m) shall be #10 or larger. For 277 V branch circuits with length from panel to first outlet exceeding 175 feet (53.34 m) shall be #10 or larger. Wire sizes for other branch circuits shall be sized to limit voltage drop to 3 %.
- E. Conductors from outlet to incandescent luminaire sockets and where run in fluorescent luminaire channels shall be type THHN or as approved by the NEC.
- F. Solid wire #10 and smaller shall be connected as specified herein and shall be made tight in conformance with manufacturers recommendations.
- G. Stranded wire shall be connected as specified herein and thoroughly taped with "Scotch" #33 or acceptable substitution approved equal electrical tape.
- H. Provide equipment lugs compatible with wire sizes indicated. Lugs shall not be rated less than equipment rating. Provide box sizes to accommodate wire bending radius requirements. Revise feeders as needed, maintaining the ampere rating and fault current values indicated, for compatibility with equipment lugs, UL listings, or manufacturer's recommendations.
- I. Install wiring after concrete, plastering, etc., work is complete. Carefully pull wire unspliced between outlets. Use approved pulling lubricant as necessary to prevent insulation cutting or nicking. Branch circuit and feeder wiring shall be color coded in accordance with NEC and in accordance with the following schedule:
 - 1. Conductor Color Coding
 - 2. Conductor Insulation Color
 - 3. Conductor

	240/120V, 1 Phase	208Y/120V 3 Phase	480Y/277V 3 Phase
Phase A	Black	Black	Brown
Phase B	Red	Red	Orange
Phase C	--	Blue	Yellow
Neutral	White	White	White
Ground	Green	Green	Green

- J. Motor circuits and feeders shall utilize stranded conductors.

3.6 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above removable ceilings or in electrical room, utility rooms, or storage areas.
- B. Pull and junction boxes shall be supported independently of the conduit system and shall be plumb. Supports shall be noncombustible and corrosion resistant. Suspended pull and junction boxes shall be supported with threaded rod hangers and galvanized steel clamps, or trapeze hangers of Unistrut or Kindorf channel.
- C. Pull and junction boxes shall be accessible.

3.7 OUTLET BOX INSTALLATION

- A. Each lighting outlet, switch, convenience outlet, communication outlet, or other miscellaneous device shall be provided with a suitable box.
- B. Convenience outlets and telephone and data outlets shall be provided with double gang boxes and single device trim plates where single devices are indicated.
- C. Where two or more similar type devices occur adjacent to each other, they shall be in a gang type box with a gang type cover. Where different type devices occur adjacent to each other, space outlet boxes so that finish plates shall be spaced 1 inch (2.54 cm) apart.
- D. Install outlet boxes securely in place, plumb with building lines in accordance with NEC Recess outside edge and associated trim plates from finished surface in accordance with NEC. Provide blank covers, which match device plates in area, for outlets not specified with covers. Outlets in plastered, paneled, and furred finishes shall be equipped with trim plates and extensions of such depths as to bring outlets flush with final surface finish.
- E. Wall outlets in exposed block or masonry construction shall have extension and device mounting straps as required to provide only such wall openings as may be covered by device plates without the use of mortar or other filler material.
- F. Sectional boxes shall not be used where outlet boxes occur in concrete.
- G. Boxes shall be supported independently of the conduit system and shall be plumb. Supports shall be noncombustible and corrosion resistant. Suspended boxes shall be supported with threaded rod hangers and galvanized steel clamps, or trapeze hangers of Unistrut or Kindorf channel. Where the suspended ceiling system is approved for the application, outlet boxes may be supported with bar hangers attached to the ceiling channels.
- H. Install additional straps or cross-bracing to ensure complete rigid installation in steel stud system, bracing prior to installation of wall finish material.

- I. "Back-to-Back" outlets in the same wall, or "thru-wall" type boxes shall not be permitted. Provide 12 inch (30.48 cm) (minimum) long nipple to offset outlets shown on opposite sides of a common wall to minimize sound transmission.
- J. Outlet boxes on opposite sides of fire rated walls and partitions shall be separated by a horizontal distance of at least 24 inches (60.96 cm).
- K. Unused knockouts in boxes shall be left sealed.
- L. Provide luminaire outlets with 3/8 inch (0.95 cm) no bolt fixture stud where required.
- M. Telephone outlets shall be mounted at the same height as adjacent receptacle outlets unless noted otherwise.
- N. Refer to architectural and electrical plans for heights of outlets.
- O. Mount outlets horizontally or vertically as directed by the CDOT Representative. Above counter outlets shall be mounted horizontally, unless otherwise noted or directed. Mount outlets at heights that comply with ADA and ANSI requirements.

3.8 WIRING METHODS FOR POWER, LIGHTING, AND CONTROL CIRCUITS

- A. Feeders: Type THHN/THWN insulated conductors in raceway.
- B. Underground Feeders and Branch Circuits: Type THWN or single-wire, Type UF insulated conductors in raceway.
- C. Branch Circuits: Type THHN/THWN insulated conductors in raceway.
- D. Remote-Control Signaling and Power-Limited Circuits: Type THHN/THWN insulated conductors in raceway for Classes 1, 2, and 3, unless otherwise indicated.

3.9 WIRING INSTALLATION

- A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- B. Install wiring at outlets with at least 12 inches (300 mm) of slack conductor at each outlet.
- C. Connect outlet and component connections to wiring systems and to ground. 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.

3.10 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.

- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load.

3.11 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.

3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
6. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.12 UTILITY COMPANY ELECTRICITY-METERING EQUIPMENT

- A. Install equipment according to utility company's written requirements. Provide grounding and empty conduits as required by utility company.

3.13 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

3.14 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.15 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 1. Raceways
 2. Building wire and connectors
 3. Supporting devices for electrical components
 4. Electrical Identification
 5. Electricity-metering components
 6. Concrete bases
 7. Cutting and patching for electrical construction
 8. Touchup painting

3.16 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Section 09 90 00 "Painting and Coating."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.17 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. Related Sections include the following:
 - 1. Section 26 27 26: Wiring Devices

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Data: For the following:
 - 1. Ground rods

1.4 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.
 - 1. Comply with UL 467.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Grounding Conductors, Cables, Connectors, and Rods:
 - a. Galvan Industries
 - b. Lyncole XIT Grounding
 - c. O-Z/Gedney Co.; a business of the EGS Electrical Group
 - d. Raco, Inc.; Division of Hubbell

e. Thomas & Betts Corporation

2.2 GROUNDING CONDUCTORS

- A. Material: Copper
- B. Equipment Grounding Conductors: Insulated with green-colored insulation.
- C. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- D. Grounding Electrode Conductors: Stranded cable
- E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- F. Bare Copper Conductors: Comply with the following:
 - 1. Solid Conductors: ASTM B 3
 - 2. Assembly of Stranded Conductors: ASTM B 8
 - 3. Tinned Conductors: ASTM B 33
- G. Copper Bonding Conductors: As follows:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch (6.4 mm) in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
 - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
- H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel
 - 1. Size: 5/8 by 96 inches (16 by 2400 mm) in diameter.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
- D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
 - 2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.
- F. Underground Grounding Conductors: Use tinned-copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade or bury 12 inches (300 mm) above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- E. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- F. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
- G. Water Heater: Install a separate equipment grounding conductor to each electric water heater. Bond conductor to heater units, piping, connected equipment, and components.
- H. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6.4-by-50-by-300-mm) grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
 1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Do not install any grounding conductors exposed on the building exterior. All grounding conductors shall be installed underground or routed indoors. Do not install any copper conductors exposed where they could be considered readily accessible to vandalizing or theft.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- G. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.
- F. Tighten screws and bolts for grounding and bonding 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.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Section 26 05 00: "Common Work Results for Electrical" for supports, anchors, and identification products.
 - 2. Section 26 27 26: "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing
- B. FMC: Flexible metal conduit
- C. IMC: Intermediate metal conduit
- D. LFMC: Liquidtight flexible metal conduit
- E. LFNC: Liquidtight flexible nonmetallic conduit
- F. RNC: Rigid nonmetallic conduit

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 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.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

- A. Available Manufacturers:
 - 1. Allied
 - 2. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 - 3. LTV Steel Tubular Products Company.
 - 4. Thomas & Betts Corporation
 - 5. Wheatland Tube Co.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.
- D. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.
- E. Plastic-Coated IMC and Fittings: NEMA RN 1.
- F. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Set-screw type.
- G. FMC: Zinc-coated steel.
- H. LFMC: Flexible steel conduit with PVC jacket.
- I. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

- A. Available Manufacturers:
 - 1. Carlon Products
 - 2. Cantex

3. Certainteed Corp.; Pipe & Plastics Group
4. Thomas & Betts Corporation

B. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.

C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

2.4 METAL WIREWAYS

A. Available Manufacturers:

1. Hoffman
2. Square D

B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 3R.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Hinged type.

F. Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. Hoffman
3. Hubbell, Inc.; Killark Electric Manufacturing Co.
4. RACO; Division of Hubbell, Inc.
5. Thomas & Betts Corporation

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

E. Hinged-Cover Enclosures: NEMA 250, Type 3R, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

F. Cabinets: NEMA 250, Type 3R, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.6 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors:

1. Exposed: Rigid steel or IMC
2. Concealed: Rigid steel or IMC
3. Underground, Single Run: RNC
4. Underground, Grouped: RNC
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC
6. Boxes and Enclosures: NEMA 250, Type 3R

B. Indoors:

1. Exposed: EMT
2. Shop Area – Concealed: EMT, or FMC
3. Office Area – Concealed: EMT or FMC
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations
5. Damp Locations: Rigid steel conduit
6. Boxes and Enclosures: NEMA 250, Type 1, except as follows:

- a. Damp or Wet Locations: NEMA 250, Type 4, nonmetallic.

C. Minimum Raceway Size: 3/4-inch trade size (DN 21).

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

3.2 INSTALLATION

- A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Section 26 05 00 "Common Work Results for Electrical."
- D. Install temporary closures to prevent foreign matter from entering raceways.

- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- F. Make bends and offsets so internal diameter is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - 1. Run parallel or banked raceways together on common supports.
 - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Use insulating bushings to protect conductors.
- K. Tighten set screws of threadless fittings with suitable tools.
- L. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- N. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

- O. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- P. Flexible Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- Q. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- R. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.
- B. Related Sections
 - 1. Section 26 05 00: Common Work Results for Electrical
 - 2. Section 26 24 16: Panelboards

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color:
 - a. Data: Black letters on orange field.
 - b. Phone: Black letters on Blue field.
 - 2. Legend: Indicates voltage and service.
- B. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.
- C. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick (152 mm wide by 0.102 mm thick).
 2. Compounded for permanent direct-burial service.
 3. Embedded continuous metallic strip or core.
 4. Printed legend indicating type of underground line.
- D. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- (0.4-mm-) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.
- E. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.
- F. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch (0.05 mm) thick, laminated with moisture-resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.
- G. Brass or Aluminum Tags: 2 by 2 by 0.05-inch (51 by 51 by 1.3-mm) metal tags with stamped legend, punched for fastener.

2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with OSHA Regulations 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: 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 the application. 1/4-inch (6.4-mm) grommets in corners for mounting.
- E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch (5 mm)
 2. Tensile Strength: 50 lb (22.3 kg) minimum
 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C)
 4. Color: According to color-coding
- B. Paint: Formulated for the type of surface and intended use.

1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- D. Install painted identification according to manufacturer's written instructions and as follows:
 1. Clean surfaces of dust, loose material, and oily films before painting.
 2. Prime surfaces using type of primer specified for surface.
 3. Apply one intermediate and one finish coat of enamel.
- E. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
 1. Bands: Pre-tensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 2. Band Locations: 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.
 3. Apply the following colors to the systems listed below:
 - a. Fire Alarm System: Red
 - b. Fire-Suppression Supervisory and Control System: Red and yellow
 - c. Combined Fire Alarm and Security System: Red and blue
 - d. Security System: Blue and yellow
 - e. Mechanical and Electrical Supervisory System: Green and blue
 - f. Telecommunication System: Green and yellow
- F. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- G. Circuit Identification Labels on Boxes: Install labels externally.
 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
 2. Concealed Boxes: Plasticized card-stock tags.

3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
- H. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.
- I. Color-Coding of Secondary Phase Conductors: Use the following colors for service, feeder, and branch-circuit phase conductors:
 1. 208/120-V Conductors:
 - a. Phase A: Black
 - b. Phase B: Red
 - c. Phase C: Blue
 2. 480/277-V Conductors:
 - a. Phase A: Brown
 - b. Phase B: Orange
 - c. Phase C: Yellow
 3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a 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. Use 1-inch- (25-mm-) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.
- J. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.
 1. Legend: 1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 2. Tag Fasteners: Nylon cable ties
 3. Band Fasteners: Integral ears
- K. Apply identification to conductors as follows:
 1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

- L. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- M. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high lettering on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
1. Panelboards, electrical cabinets, and enclosures
 2. Access doors and panels for concealed electrical items
 3. Electrical switchgear and switchboards
 4. Emergency system boxes and enclosures
 5. Disconnect switches
 6. Enclosed circuit breakers
 7. Motor starters
 8. Push-button stations
 9. Contactors
 10. Control devices
 11. Transformers
 12. Telephone switching equipment
 13. Fire alarm master station or control panel

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:
 - 1. Lighting and appliance branch-circuit panelboards.
- B. Related Sections include the following:
 - 1. Section 26 05 53: Identification for Electrical Systems
 - 2. Section 26 28 13: Fuses

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference
- B. GFCI: Ground-fault circuit interrupter
- C. RFI: Radio-frequency interference
- D. RMS: Root mean square
- E. SPDT: Single pole, double throw

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, accessory and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings and finishes.
- B. Field Test Reports: Submit written test reports and include the following:
 - 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.

- D. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Section 01 77 00 "Closeout Procedures," 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.

1.5 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 NEMA PB 1.
- C. Comply with NFPA 70.

1.6 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, and encumbrances to workspace clearance requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Div.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.

2.2 FABRICATION AND FEATURES

- A. Enclosures: Surface-mounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at installed location.
- B. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- C. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
- D. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

- E. Bus: Hard-drawn copper, 98 percent conductivity.
- F. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.
- G. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- H. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- I. Gutter Barrier: Arrange to isolate individual panel sections.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
- B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 1, 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. GFCI Circuit Breakers: Single- and two-pole configurations with 30-mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mounting Heights: Top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- D. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- E. Install filler plates in unused spaces.
- F. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 53 " Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.
- B. 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.

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. 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.
- C. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 26 28 13
FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, controllers, and motor-control centers; and spare fuse cabinets.
- B. Related Sections include the following:
 - 1. Section 26 24 16: Panelboards
 - 2. Section 26 28 16: Enclosed Switches and Circuit Breakers

1.3 SUBMITTALS

- A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.
- B. Maintenance Data: For tripping devices to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Provide fuses from a single manufacturer.
- B. 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.
- C. Comply with NEMA FU 1.
- D. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Cooper Industries, Inc.; Bussmann Div.
 2. General Electric Co.; Wiring Devices Div.
 3. Tracor, Inc.; Littelfuse, Inc. Subsidiary

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Main Service: Class RK1, fast acting
- B. Main Feeders: Class RK1, fast acting
- C. Motor Branch Circuits: Class RK5, time delay
- D. Other Branch Circuits: Class RK5, fast acting

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Provisions of The General Conditions of the Contract (Design/Bid/Build) and Division 1 General Requirements and applicable provisions elsewhere in the contract documents apply to this Section.

1.2 SUMMARY

- A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:
 - 1. Service disconnecting means
 - 2. Feeder and branch-circuit protection
 - 3. Motor and equipment disconnecting means
- B. Related Sections include the following:
 - 1. Section 26 27 26: "Wiring Devices" for attachment plugs, receptacles, and toggle switches used for disconnecting means.
 - 2. Section 26 28 13: "Fuses" for fusible devices.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter
- B. RMS: Root mean square
- C. SPDT: Single pole, double throw

1.4 SUBMITTALS

- A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- B. Field Test Reports: Submit written test reports and include the following:
 - 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. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Section 01 77 00 "Closeout Procedures," include the following:
 - 1. Routine maintenance requirements for components.
 - 2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
 - 3. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 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 NEMA AB 1 and NEMA KS 1.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Fusible Switches:
 - a. Eaton Corp.; Cutler-Hammer Products
 - b. General Electric Co.; Electrical Distribution & Control Division
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
 - 2. Molded-Case Circuit Breakers:
 - a. Eaton Corp.; Cutler-Hammer Products
 - b. General Electric Co.; Electrical Distribution & Control Division
 - c. Klockner-Moeller
 - d. Siemens Energy & Automation, Inc.
 - e. Square D Co.

2.2 ENCLOSED SWITCHES

- A. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.

2.3 ENCLOSED CIRCUIT BREAKERS

- A. Molded-Case Circuit Breaker: NEMA AB 1, 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 Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with 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 I^2t 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 30-mA trip sensitivity.
 - 7. Molded-Case Switch: Molded-case circuit breaker without trip units.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2.4 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R
 - 2. Wash Bay: NEMA 250, Type 4
 - 3. Kitchen Areas, Restrooms or Other Wet or Damp Indoor Locations: NEMA 250, Type 4

2.5 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.

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.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 53 "Identification for Electrical Systems."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 CONNECTIONS

- A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.
- B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.
- C. 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.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.
 2. Test continuity of each line- and load-side circuit.
- B. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. 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.

3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION