PROJECT SPECIFICATIONS

DMVA PROJECT NO. 420591 (88821)

For

BUILDING 11-89 TISA
ENERGY UPGRADES

AREA 11
FORT INDIANTOWN GAP
ANNVILLE – LEBANON COUNTY – PENNSYLVANIA - 17003

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF MILITARY AND VETERANS' AFFAIRS
ANNVILLE, PENNSYLVANIA

Josh Shapiro, GOVERNOR
Major General Mark J. Shindler, ADJUTANT GENERAL

Date: 29, April 2024

DESIGN PROFESSIONALS

Office of Facilities and Engineering
Bureau of Design and Project Management
Bldg. 0-10, Chapel Road, Ft. Indiantown Gap
Annville, Lebanon County, Pa. 17003
Phone: (717) 861-6487 Fax: (717) 861-8583

DRAWINGS

NUMBER AND TITLE OF DRAWINGS

The drawings which form a part of this project are indicated in the following list:

G.1.1	COVER SHEET
G.1.2	PROJECT INFORMATION
C.1.0	EXISTING SITE PLAN
C.2.0	ENERGY UPGRADES SITE PLAN
C.2.1	FENCE DETAILS
C.3.0	E&S PLAN
C.3.1	E&S NOTES AND DETAILS
AD.1.0	DEMO PLAN – AREA 'B'
AD.1.1	DEMO CEILING PLAN – AREA 'B'
A.1.1	FLOOR PLAN – AREA 'B'
A.1.2	CEILING PLAN – AREA 'B'
A.2.1	SCHEDULES & DETAILS
A.3.1	DETAILS
A.3.2	ELEVATIONS & DETAILS
S.1.1	SECTIONS & DETAILS
H.0.1	SYMBOLS & NOTES
H.1.0	DEMO PLAN - MECHANICAL
H.1.1	FLOOR PLAN - MECHANICAL
H.1.2	PART PLAN – MECHANICAL
H.3.1	SCHEMATIC PIPING
H.3.2	SECTIONS – MECHANICAL
H.3.3	SECTIONS – MECHANICAL
H.3.4	SECTIONS - MECHANICAL
H.4.1	SCHEDULES - MECHANICAL
H.4.2	DETAILS - MECHANICAL
H.5.1	SITE PLAN – MECHANICAL
H.5.2	SITE DETAILS - MECHANICAL
H.5.3	WELL FIELD LAYOUT
P.1.0	DEMO PLAN – PLUMBING
P.1.1	OVERALL PLAN - PLUMBING
P.2.1	PLUMBING DETAILS
FP.1.1	FP – ROOF SYSTEM
FP.1.2	FP – CEILING SYSTEM
FP.1.3	FP – IN-RACK SYSTEM
FP.1.4	FP – DETAILS
E.0.1	LIGHTING DEMOLITION PLAN
E.0.2	POWER DEMOLITION PLAN
E.0.3	REFRIGERATION DEMOLITION PLAN
E.1.1	LIGHTING PLAN
E.1.2	POWER PLAN
E.2.1	RISER DIAGRAM
E.3.1	PANEL SCHEDULES
E.4.1	DETAILS

ES.5.1	SOLAR PLOT PLAN
ES.5.2	SOLAR ONE-LINE
ES.5.3	SOLAR MOUNTING DETAILS
ES.5.4	CONDUIT DETAILS
ES.5.5	SOLAR FIELD DETAILS
ES.5.6	SOLAR FIELD NOTES

The above is an exact list of the drawings included under Project No. 420591(88821), Bldg. 11-89 TISA, Energy Upgrades and shall be considered a part thereof.

Bureau of Design and Project Management will furnish from time to time as the work progresses, such supplemental drawings as may be required for further illustrating the details of the work, but these supplemental drawings will not include the shop drawings, all of which are to be prepared by the Contractor and submitted as hereinafter specified for approval before the work is started.

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GENERAL CONSTRUCTION

PLUMBING CONSTRUCTION

HVAC CONSTRUCTION

ELECTRICAL CONSTRUCTION

SECTION 010100

SUMMARY OF WORK

PART 1 – GENERAL

1.1 STIPULATIONS

A. The specifications "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SCOPE OF WORK, GENERAL

A. The work under this Contract shall generally consist of, but not necessarily be limited to, providing all labor, material, devices, tools and equipment required for the construction of a mechanical and pump room, Insulated wall/ceiling panels for coolers and freezers, upgrades to the existing mechanical and electrical systems, Hybrid Ground Source Heat Pump Loop, Photovoltaic Solar Array and all associated infrastructure to support these upgrades for Building 11-089 located at Fort Indiantown Gap, Annville, Lebanon County, PA and shall be in total accordance with the specifications and drawings and subject to the terms and conditions of all other Contract Documents.

1.4 PERFORMANCE PERIOD

A. ***Total days*** (**450**) calendar days from Government granted Notice to Proceed.

1.5 WAGE SCALES

A. Wage Scales ARE REQUIRED to be paid on this Project.

1.6 QUESTIONS DURING BID PROCESS.

A. Direct all questions pertaining to the project as shown and described in the contract documents to all persons listed below.

Melanie Morris
DMVA, Bureau of Military Construction & Engineering
Bldg. 0-10, Fort Indiantown Gap
Annville, PA 17003
Email: melmorris@pa.gov
Ph.: 717.861.6487 Fax: 717.861.8683

Tina Rebuck
Department of Military and Veterans Affairs State Contracting Office
Building 0-47, Fort Indiantown Gap
Annville, PA 17003
Email: trebuck@pa.gov
Ph.: 717-861-8794

Dan Conley – Project PM
DMVA, Bureau of Military Construction & Facility Management
Bldg. 11-19, Utility Road, Ft Indiantown Gap
Annville, PA 17003
Email: daconley@pa.gov
Ph.: 717-861-8413

B. Should the contractor submit an RFI via email, the subject line shall appear as follows:

1. **DMVA Project#: 42591-88821_Bldg. 11-89 TISA – Energy Upgrades**
2. Additional information can be included thereafter.

1.7 SUBMITTALS

A. See individual Sections and "SCHEDULE OF MATERIAL SUBMITTALS (AF FORM 66)" included within the project Design Documents

B. Submittals shall be forwarded to Department of Military & Veteran's Affairs; Division of Engineering and Architecture, Building 0-10, Fort Indiantown Gap, Annville, Pa 17003

C. Each submittal shall include the following:

1. Project number
2. Contract number
3. Related specification section
4. Contractor's approval stamp
5. Contractors initials and date
6. Area for DMVA-BMCE review stamp

D. All submittals must be approved by the discipline responsible, DMVA-BDPM **Designer of Record** prior to incorporation into the project.

1.8 REQUIRED WARRANTIES

A. Contractor shall provide all required warranties as outlined within the Project Design Specifications and on all included Government AF Form 66's.

PART 2 – OUTLINE OF REQUIRED WORK

2.1 The work of this project consists of but is not necessarily limited to the following. Detailed requirements of the work are described on the pertinent specification sections and/or shown on the drawings.

A. (GENERAL – POINT 1)

1. Prepare and submit all necessary pre-construction documentation as outlined within the project Design Documents.
2. Demolish items in accordance with the demolition notes listed on drawing AD.1.0 and AD.1.1.
3. Install all exterior site facility features, to include but not limited to, E&S Controls, earthmoving, paving, aggregate compound, fencing, etc. as depicted within the Project Design Documents.
4. Install all exterior facility features, to include but not limited to, doors, explosion relief vents, etc. as depicted within the Project Design Documents.
5. Install all interior facility features, to include but not limited to, walls, structural steel, masonry, blocking, doors, ceilings, insulated wall/ceiling panels, etc. as depicted within the Project Design Documents.
6. Complete Punch Lists and Final Cleaning.
7. Provide all required closeout documentation and training per the Project Design Documents prior to deeming/granting the project complete.

B. (HVAC – POINT 2)

1. Prepare and submit all necessary pre-construction documentation as outlined within the project Design Documents.
2. Demolish/remove existing HVAC per Project Design Documents.
3. Install Air Handlers, Split Systems & Condensing Units as per Project Design Documents.
4. Install Geo-Thermal Bore Field, Pumps, Piping, Adiabatic Fluid Cooler, etc. as per Project Design Documents.
5. Install Cooler/Freezer Condenser Water System and Evaporator Units per the Project Design Documents.
6. Install all HVAC controls as per the Project Design Documents.
7. Provide certified Testing, Adjusting, and Balancing to HVAC System and Reports.
8. Provide all required closeout documentation and training per the Project Design Documents prior to deeming/granting the project complete.
9. Provide Boilers, Pumps, Piping, Accessories required to update the freezer under floor hydronic heating system.
10. Rehabilitate the interstitial space ventilation system surrounding the coolers and freezers. Updates to include an additional roof mounted exhaust fan, and new damper actuators along the outside walls.

C. (PLUMBING – POINT 3)

1. Prepare and submit all necessary pre-construction documentation as outlined within the project Design Documents.
2. Excavations & Installation of Drain Piping as per the Project Design Documents
3. Indoor Sanitary Waste and Vent Line Installation to include saw cutting concrete as required, as per the Project Design Documents.
4. Plumbing Fixtures Installation and Rough-Ins, as per the Project Design Documents.
5. Indoor Domestic Water Line installation and related Insulation, as per the Project Design Documents.
6. Modifications to existing fire suppression system, as per the Project Design Documents.

7. Final Cleaning, Punch List Items, Close-Out Documents.

D. (ELECTRICAL – POINT 4)

1. Prepare and submit all necessary pre-construction documentation as outlined within the project Design Documents.
2. Perform demolition as per the drawings and stage accordingly for most efficient construction methods.
3. The electrical distribution system consists of a Main Distribution Panel and sub-panels for lighting, power and mechanical systems which require minor modifications, as per Project Design Documents.
4. Provide Lighting in new mechanical spaces with high efficiency LED lighting with only standard switch controls, as per Project Design Documents.
5. Emergency lighting shall consist of integral battery type units and LED exit signs, as per Project Design Documents.
6. Install new ground mounted Photovoltaic Solar Array, to include all inverters, infrastructure all other components, as per Project Design Documents.
7. The communication/data system shall be provided as per Project Design Documents.
8. Provide equipment connections and controls as per Project Design Documents.
9. Convenience outlets are located throughout the facility and shall be connected as as per Project Design Documents.
10. Provide conduit, boxes and cables for security system as per Project Design Documents.
11. Final Cleaning, Punch List Items, Close-Out Documents.

END OF SECTION 010100

SECTION 010300

BASE BID DESCRIPTIONS

Part 1 GENERAL

1.1 STIPULATIONS

A. The specifications "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Identification of each Base Bid and description of the basic changes to be incorporated in the work.

1.4 DESCRIPTION OF SEPARATE BASE BIDS

A. GENERAL CONSTRUCTION (Point 1)

1. Base Bid No. 1:

   a. General Construction supporting HVAC, Plumbing and Electrical upgrades, new cooler and freezer wall & ceiling panels, new masonry, steel framing and concrete work for mechanical & pump rooms, excavation, fencing, paving and site controls and all other general construction work supporting the installation of the geo-thermal well system and photovoltaic solar array systems, as described in the project drawings and specifications.

2. Base Bid No. 2:

   a. All work included in Base Bid No. 1 and additional general construction work supporting the enhanced photovoltaic solar array systems and the enhanced geo-thermal well field installation, as described in the project drawings and specifications.

3. Base Bid No. 3:

a. All work included in Base Bid No.'s 1 and 2 and replacement of 3 ea. insulated cooler doors (door #'s 106, 107, & 108) and associated work supporting the replacement, as described in the project drawings and specifications..

B. HVAC (Point 2)

1. Base Bid No. 1:

a. Geothermal system including wells (A2, A3, A5, A6, A7, B1, B3, B4, B5, B6, B7, B9, B10, C3, C5, C6, C8, C9, C10, D1, D2, D3, D4, D5, D7, D8, D9, D10, E1, E2, E3, E5, E7, E8, E10, F2, F3, F4, F5, F6, F7, F9, F10, F11, F12, G3, G4, G5, G7, G8, G9, G11, G12, H4, H6, H7, H9, H10, H11, H12, H13, I6, I7, I9, I10, I11, MWI-1, MWI-2, MWI-3, MWM-1, MWM-2, MWM-3, MWM-4, MWM-5, MWM-6, MWO-1, MWO-2, MWO-3, MWO-4, MWO-5, MWO-6) and all associated work supporting these systems, new refrigeration/freezer systems, HVAC controls and all other associated HVAC work, as described in the project drawings and specifications..

2. Base Bid No. 2:

a. All work included in Base Bid No. 1 and add Geothermal wells (C1, C2, E4, I5, H5, G6, I12, G10, F8, E12, E11, E9, A4, B5, D6, A8, B8, C7, A1, B2, C4, I8, H8, E6) and all associated work supporting these additions, as described in the project drawings and specifications..

3. Base Bid No. 3: No additional HVAC work in this Base Bid

C. PLUMBING (Point 3)

1. Base Bid No. 1:

a. All plumbing work associated with the project, fire suppression modifications, drain lines and all other related plumbing work associated with the Geo-thermal systems for this Base Bid, as described in the project drawings and specifications..

2. Base Bid No. 2:

a. All work included in Base Bid #1 and all additional plumbing work supporting the additional wells for the geothermal system, as described in the project drawings and specifications..

3. Base Bid No. 3: No additional Plumbing work associated with the project

D. Electrical (Point 4)

1. Base Bid No. 1:

a. Demolition of existing electrical and lighting systems within the exg. freezers and coolers, as described in the project drawings and specifications.

b. Installation of 340 KW PV Solar Array, to include all suporitng infrastructure, as described in the project drawings and specifications.

c. All electrical work associated with the install of new refrigeration/freezer system and geo-thermal well field system, as described in the project drawings and specifications.

2. Base Bid No. 2:

   a. All work associated with Base Bid No. 1 and add 85 KW PV Solar Array system for a complete 425 KW PV Solar Array system, to include all other supporting systems and infrastructure, as described in the project drawings and specifications.

3. Base Bid No. 3:

   a. All work associated with Base Bid No.'s 1 & 2 and electrical connections and infrastructure associated with the installation of insulated cooler door No.'s 106, 107 and 108, as described in the project drawings and specifications..

END OF SECTION

SECTION 011200

COORDINATION AND CONTROL

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section includes a summary of each contract, including responsibilities for coordination and temporary facilities and controls that govern the performance of the work to complete this project.

B. Specific requirements for work of each contract are also indicated in individual Specification Sections and on Drawings.

1.4 PRIME CONTRACTS FOR CONSTRUCTION

A. Point 1 – General (Lead)

B. Point 2 – HVAC

C. Point 3 – Plumbing

D. Point 4 – Electrical

1.5 WORK HOURS

A. Regular work hours will be Monday through Friday, 7:00 am to 4:30 pm.

B. Holidays: No work will be allowed on holidays observed by the State and Federal Government.

C. Weekends: No work will be allowed on weekends.

D. Exceptions: If deemed necessary, exceptions to the above can be made. Prime Contractors must submit, in writing, justification for such an exception and approval from the Department must be obtained prior to commencement of any work.

1. Fort Indiantown Gap: Any and all work that takes place outside of the working hours as listed herein, shall be coordinated with the DMVA-FTIG Construction Manager. Contractor(s) performing work on approved dates shall submit, in writing, a list of all employees that will be on site for the days approved. This list of employees will be submitted to the Fort Indiantown Gap Police Dept. by the DMVA-FTIG Construction Manager.

1.6 COORDINATION

A. The General Contractor shall be responsible for coordination between all contracts.

1. Construction operations shall be coordinated to ensure efficient and orderly installation of each part of the work.

2. Coordinate installation of different components with other Contractors to ensure accessibility for required construction operations.

3. Make necessary provisions to accommodate items scheduled for later installation.

PART 2 - TEMPORARY FACILITIES AND EQUIPMENT

2.1 GENERAL

A. It shall be the responsibility of each Contractor to provide, maintain, and remove all facilities and equipment necessary for construction operations for individual Contracts.

1. These items include, but are not limited to:

a. Costs and use charges associated with the facility.

b. Plug-in cords, power cords, and extension cords, power tools.

c. Task lighting and special lighting necessary for construction operations.

d. Storage and fabrication structures/areas.

e. Temporary enclosures for construction activities.

f. Hoisting equipment for construction activities.

g. Waste disposal facilities, including collection and legal disposal of its own waste materials.

h. Daily cleaning of work area.

i. Secure lockup of tools, materials, and equipment.

j. Construction aids, services, and facilities necessary for individual construction activities.

2.2 FIELD OFFICES

A. CONTRACTOR TRAILERS/OFFICES

1. The Prime Contractor(s) shall provide and maintain, at their cost, a suitable office on the premises. Trailer/offices shall be located based on the either the staging area depicted on the Project Design Documents and/or the location determined during the Pre-Construction Coordination Meeting. The Contractor shall provide and maintain all necessary services and utilities for their respective offices and/or trailers, to include, but not limited to; electrical services, sanitary and water services, heating and cooling, telephone/fax and internet services.

B. SANITARY FACILITIES

1. Portable Toilets (Porta Johns) – Point 1 General Contractor (Lead), at their costs, shall be responsible for providing and maintaining any and all temporary toilet facilities. Toilets are to be utilized by all persons (Contractors, Sub-Contractors, DMVA Personnel, etc.) associated with the project.

a. Cleaning, Pumping and Maintenance of the portable toilets shall be the responsibility of the Point 1 General Contractor.

PART 3 - TEMPORARY SERVICES/UTILITIES DURING CONSTRUCTION

3.1 CONTRACTOR RESPONSIBILTIES

A. The General Contractor shall be responsible for all temporary heating, cooling, ventilation, power, lighting and water/sewer. This shall include, unless otherwise indicated, utility-use charges, temporary meters, and temporary connections, necessary during construction operations.

B. The designated Contractor shall install, operate, protect and maintain the respective temporary services as specified herein during the duration of the entire project.

C. Temporary connections to new and/or existing permanent service lines shall be made at locations as directed by the Department, and when the temporary service lines are no longer required, they shall be removed by the Contractor. Any part or parts of the permanent service lines, grounds and building, disturbed and damaged by the installation and/or removal of the temporary service lines, shall be restored to their original condition by the Contractor responsible for the temporary installation.

D. If the Contractor fails to carry out its responsibility in supplying temporary services as set forth in this contract it is responsible for such failure and the Department may take such action as it deems proper for the protection and conduct of the work and shall deduct the cost involved from the amount due the Contractor. Only those temporary utilities required for construction need to be extended to the work area(s).

3.2 INTERRUPTION OF SERVICES

A. Each Prime Contractor shall have all needed equipment and material to complete planned work at the site prior to shutting down any system.

B. No additional compensation or time will be given to the Contractor if work must be performed on State or National Holidays or on weekends or on overtime. See Paragraph 1.4 on 'Working Hours'.

3.3 WELDING

A. Any Contractor using electrical power for welding on the site shall use self-contained engine generating units.

3.4 FIRE EXTINGUISHERS

A. Each Contractor shall provide UL listed, NFPA approved fire extinguishers (ten (10) lb. minimum) at the construction site during operations, suitable for all types of fires in accordance with OSHA.

PART 4 - RESTORATION AND REPAIRS

4.1 RESTORATION

A. All restoration required due to contract operations, shall be the responsibility of each individual Contractor for their location/area of operation, at no expense to the Department.

4.2 REPAIRS

A. Each individual Contractor shall be responsible for any and all repairs to work areas, to include repairs to both existing finishes and completed work.

B. Individual Contractors will not be responsible for damages resulting from on-going work, neglect and/or carelessness of other contractors and/or their associated sub-contractors. Parties responsible for any damages, no matter the circumstances, will be required to repair all damages at no expense to the Department.

END OF SECTION

SECTION 012200
UNIT PRICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for unit prices.

B. Related Section:

1. Division 01 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

1.2 DEFINITIONS

A. Unit price is a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.3 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, overhead, and profit.

B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

A. Unit Price: .2 HVAC
1. Geo-Thermal Bore Hole

a. Drilling one 300 ft geothermal bore hole
b. 20 ft of steel casing
c. Bore hole grouting
d. 1-1/4” HDPE supply and return tubing (620 ft total) with u-bend fitting.

END OF SECTION 012200

SECTION 013100

SEQUENCE OF CONSTRUCTION AND MILESTONES

PART 1 – GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions of the Construction Contract", and "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 GENERAL REQUIREMENTS

A. Before beginning work, the Contractor will be required to prepare a schedule in consultation with the Department. The work must be carried out in full accordance with the schedule. The Contractor shall arrange without any unnecessary interference with the Institution's operation.

1.3 CRITICAL MATERIALS AND EQUIPMENT

A. The Contractor is cautioned that all necessary and required critical materials and equipment shall be ordered as quickly as possible, in order that the shipping will not delay the progress of the work or completion of the project.

1.4 CRITICAL ITEMS TO BE NOTED AS MILESTONES

A. Refer to the General Conditions regarding construction progress Milestones to be established by the Lead Contractor.

B. The Lead Contractor shall submit a construction schedule, for the total project, including all prime contractors critical path work items. The schedule shall be submitted at the pre-construction meeting. The schedule will be reviewed and approved by the designer and the using agency to confirm compliance with construction sequencing and Using Agency training schedule.

1. GENERAL CONSTRUCTION

    a. Construction Sequencing

        1) Submittals
        2) Mobilization
        3) Erosion & Sedimentation Control Features
        4) Demolition
        5) Excavation
        6) Concrete – Slab on Grade, Curbs, Footers
        7) Walls – CMU, Concrete, Insulated Panels
        8) Ceilings – Insulated Panels
        9) Bar Joists & Metal Decking

10) Insulation (general)
11) Doors
12) Painting
13) Final Grading, Seeding, where applicable
14) Final Cleaning, Punch List Items, Close-Out Documents

2. HVAC (.2)

   a. Construction Sequencing

      1) Submittals
      2) Mobilization
      3) Perform all required HVAC demolition as noted on the plans.
      4) Install a new ductless split system.
      5) Install new heating, air conditioning, and exhaust systems.
      6) Install geo-thermal well field, pumps, piping and all other associated systems.
      7) Install new automatic temperature controls.
      8) Install diffusers, grilles and accessories.
      9) Provide certified Testing, balancing and Adjustment to HVAC System and Reports.
      10) Provide all required closeout documentation and training per the Project Design Documents prior to deeming/granting the project complete.

3. PLUMBING (.3)

   a. Construction Sequencing

      1) Submittals
      2) Install sanitary, waste and vent piping including floor drains.
      3) Install domestic water piping and insulation.
      4) Install plumbing fixtures, piping and accessories.
      5) Install water heater and venting.
      6) Install gas piping to HVAC equipment.
      7) Relocate and install new Fire Suppression systems
      8) Final Cleaning, Punch List Items, Close-Out Documents.

4. ELECTRICAL (.4)

   a. Construction Sequencing

      1) Submittals
      2) Mobilization
      3) Demolition
      4) Underground Rough-Ins
      5) Photovoltaic Solar Array Rough-Ins
      6) Photovoltaic (PV) Solar Array Panels, Inverters, and all other equipment associated with the PV system.
      7) Panel Rough-Ins
      8) Branch Circuit Rough-Ins
      9) Fire Alarm Rough-Ins

10) Security System Rough-Ins
11) Data Rough-Ins
12) Security Wiring
13) Fire Alarm Wiring
14) Data Wiring
15) Branch Circuit Wiring
16) Installation of Lighting
17) Telecom Cable, Boxes and Outlets
18) Final Connections
19) Final Cleaning, Punch List Items, Close-Out Documents.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 013000
SUBMITTALS

Part 1 GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions of Contract" and "General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SECTION INCLUDES/CONTENT

A. Included in this section of the specifications is a list of approvals required for all materials incorporated into the project. The Department reserves the right to require additional approvals if necessary. No material, equipment or supplies listed herein shall be incorporated into the work until the Contractor has obtained prior approval from the Department.

B. Submittals required by each prime contract are indicated within AF Form 66 “Schedule of Material Submittals” attached to the end of Section 01300.

1.3 SUBMITTAL PROCEDURES

A. Refer to ‘Submittals’ of the General Conditions.

B. Comply with the following or resubmission will be required:

1. Indicate contract number, specification section and building number (as shown on the drawings) on each item submitted.

2. Signify approval by stamp, initialing and dating each item prior to submission to the Professional.

C. Items requiring testing shall be forwarded directly to the approved laboratory. The Contractor shall pay all costs associated with testing.

D. Expedite critical materials, equipment and shop drawings, and other required submissions.

E. Incomplete submissions will be returned for resubmission.

F. Use of substitutions for materials or details shown on the contract drawings or called for in these specifications require written approval from the Department. See General Conditions.

1.4 PRODUCT DATA

A. Manufacturer's printed directions and manufacturer's standard specifications showing all dimensions, cuts, finishes, etc., as well as catalog cuts and ratings of all material will be required and shall be submitted in advance prior to application and/or installation.

1.5 TESTS

A. Refer to 'Tests' of the General Conditions.

B. Submit required reports listing items tested, tests conducted and results obtained as specified.

1.6 CERTIFICATIONS

A. Submit required certifications in written form identifying authorized representative, manufacturer, systems designer and other required data as specified.

1.7 WARRANTIES

A. Refer to Specifications for required warranties. Copies of proposed warranties specified for products shall accompany the designated submittal of that product.

1.8 OPERATION AND MAINTENANCE MANUALS

A. Manual Format (Use 3-ring binder):

1. Title page with the following information for each system covered:

a. Project Title and DMVA Contract Number (in capital letters)

b. Name of Company

c. Name of the individual to be called

d. Normal telephone numbers

e. Contractor's account number for project

2. Index listing all sections of the Manual.

3. Warranties for equipment furnished in contract. (Index tabbed)

4. Complete system circuit diagrams, block diagrams, copies of all approved shop drawings, which shall clearly illustrate how all the components relate and how they are interconnected and a point wiring diagram.

5. Reports, testing analysis.

6. Operating instructions and maintenance instructions for all equipment and finish materials furnished.

1.9 SUBMITTALS LIST

A. See attached AF FORM 66 “Schedule of Material Submittals” organized by prime contract.

Part 2 N/A

Part 3 N/A

END OF SECTION 013000

SCHEDULE OF MATERIAL SUBMITTALS **General (.1) - Civil Submittals**													PROJECT NUMBER **420591 (88821)**								PROJECT TITLE **Bldg. 11-89 TISA, Energy Upgrades**
TO BE COMPLETED BY PROJECT ENGINEER													TO BE COMPLETED BY CONTRACT ADMINISTRATOR								
LINE NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL	NUMBER OF COPIES REQUIRED											REQUIRED SUBMISSION DATE	DATE RECEIVED IN CONTRACTING	DATE TO CIVIL ENGINEERING	RETURN SUSPENSE DATE	SUBMITTAL NUMBERS	DATE CONTRACTOR NOTIFIED		CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
		CERTIFICATE OF COMPLIANCE	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	CATALOG DATA	OPERATING INSTRUCTIONS	Reports	Batch Slips	Steel Certifications						APPROVED	DIS-APPROVED			
1	312000 Aggregate PENNDOT Certificates	**1**								**1**	**1**		**IJC +10**									A,B
2	312000 Laboratory & Placed Compaction results of utility trenches, select fill & aggregate	**1**								**1**			**IJC +10 / WC +3**									A,B
3	321216 – Bituminous Concrete Paving – mix design	**1**								**1**	**1**		**IJC +10**									A,B
4	323113 – Chain Link Fence system, concrete & Gates		**1**					**1**					**IJC +10**									
5	329200 – Seed mix, Fertilizer, straw or matting					**1**				**1**			**Com +3**									A,B

A. No deviations, substitutions or changes of materials, to be incorporated into this project, shall be made after approval by the Department, except for written direction by and the approval of the manufacturer of a specific item and re-approval by the Department.

B. The Department retains the right to require additional items not specifically denoted to be submitted for approval and/or additional clarification.

SCHEDULE OF MATERIAL SUBMITTALS **(POINT 1 - GENERAL)**	PROJECT NUMBER **420591 (88821)**	PROJECT TITLE Bldg. 11-89 TISA, Energy Upgrades

TO BE COMPLETED BY PROJECT ENGINEER	TO BE COMPLETED BY CONTRACT ADMINISTRATOR

LINE NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL (DWG's.) SPEC SECTION	NUMBER OF COPIES REQUIRED										REQUIRED SUBMISSION DATE PRIOR TO INSTALL	DATE RECEIVED IN CONTRACTING	DATE TO ENGINEERING	RETURN SUSPENSE DATE	SUBMITTAL NUMBERS	DATE CONTRACTOR NOTIFIED		CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
		CERTIFICATE OF COMPLIANCE	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	CATALOG DATA	AS-BUILT DRAWINGS	O & M MANUALS	OPERATIONS DEMONSTRATION						APPROVED	DIS-APPROVED			
1	033000 Stone Base	X						X													
2	033000 Rebar & WWF	X	X					X													
3	033000 Concrete/Mix Designs	X						X													
4	033000 Vapor Barrier	X						X													
5	042000 Unit Masonry	X				X		X													
6	052100 Steel Bar Joists	X	X			X	X	X													
7	053100 Steel Decking	X	X			X	X	X													
8	061053 Misc. Rough Carpentry	X						X													
9	061600 Sheathing	X				X	X	X													
10	072101 Spray Foam Insulation	X				X	X	X		X											
11	074217 Insul (Cooler/Freezer) Wall Panels	X	X			X	X	X	X	X											
12	079200 Joint Sealants	X			X	X	X	X													
13	081113 Mtl Door & Frames	X	X			X	X	X	X	X											
14	083613 Sectional Doors	X	X		X	X	X	X	X	X											

SCHEDULE OF MATERIAL SUBMITTALS **(POINT 1 - GENERAL)**	PROJECT NUMBER **420591 (88821)**	PROJECT TITLE Bldg. 11-89 TISA, Energy Upgrades

TO BE COMPLETED BY PROJECT ENGINEER	TO BE COMPLETED BY CONTRACT ADMINISTRATOR

LINE NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL (DWG's.) SPEC SECTION	NUMBER OF COPIES REQUIRED										REQUIRED SUBMISSION DATE PRIOR TO INSTALL	DATE RECEIVED IN CONTRACTING	DATE TO ENGINEERING	RETURN SUSPENSE DATE	SUBMITTAL NUMBERS	DATE CONTRACTOR NOTIFIED		CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
		CERTIFICATE OF COMPLIANCE	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	CATALOG DATA	AS-BUILT DRAWINGS	O & M MANUALS	OPERATIONS DEMONSTRATION						APPROVED	DIS-APPROVED			
15	083614 Cold Storage Doors	X	X		X	X	X	X	X	X											
16	087111 Door Hardware	X	X			X	X	X		X											
17	089516 Explosion Relief Vents	X	X	X	X	X	X	X	X	X											
18	092216 N.S. Mtl. Framing	X	X			X	X	X													
19	099113 Exterior Primer & Paint	X		X	X	X	X	X		X											
20	099123 Interior Primer & Paint	X		X	X	X	X	X		X											
21	111300 Dock Seal & Head Pad	X	X		X	X	X	X		X											
22	**As-Built dwgs, CAD & printed (1 Set)**								**X**												
23																					
24																					
25																					
26																					
27																					
28																					

SCHEDULE OF MATERIAL SUBMITTALS **HVAC (.2)**												PROJECT # **DMVA/BMCE-420591(88821)**						PROJECT TITLE TISA 11-89 ENERGY UPGRADES		
TO BE COMPLETED BY PROJECT ENGINEER												TO BE COMPLETED BY CONTRACT ADMINISTRATOR								
LINE NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL	NUMBER OF COPIES REQUIRED										REQUIRED SUBMISSION DATE	DATE RECEIVED IN CONTRACTING	DATE TO MECHANICAL ENGINEERING	RETURN SUSPENSE DATE	SUBMITTAL NUMBERS	DATE CONTRACTOR NOTIFIED		CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
		STEEL CERTIFICATE OF COMPLIANCE	SHOP DRAWINGS	SCHEDULES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	CATALOG DATA	OPERATING INSTRUCTIONS	REPORTS	DELEGATED DESIGN						APPROVED	DIS-APPROVED			
1	230529-Hangers and Supports for HVAC Equip. & Piping		5					5				NTP +10									A,B
2	230548 Vibration Controls for HVAC Piping and Equipment		5					5				NTP +10									A,B
3	230553_Mechanical Identification		5					5				NTP +10									A,B
4	230593-Testing, Adjusting and Balancing									5											A,B
5	230719_HVAC Piping Insulation		5					5				NTP +10									A,B
6	232113.33 - Ground-Loop Piping		5					5				NTP +10									A,B
7	232116 - Hydronic Piping Specialties																				
8	232123 - Hydronic Pumps		5					5				NTP +10									A,B
9	232300 - Refrigerant Piping		5					5				NTP +10									A,B
10	232513 - Water Treatment for Closed-Loop Hydronic Systems		5					5				NTP +10									A,B
11	233113- Metal Ducts		5					5				NTP +10									A,B
12	233423 – HVAC Power Ventilators		5				5	5	5			NTP +10									A,B

SCHEDULE OF MATERIAL SUBMITTALS **HVAC (.2)**												PROJECT # **DMVA/BMCE-420591(88821)**								PROJECT TITLE TISA 11-89 ENERGY UPGRADES
TO BE COMPLETED BY PROJECT ENGINEER												TO BE COMPLETED BY CONTRACT ADMINISTRATOR								
LINE NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL	NUMBER OF COPIES REQUIRED										REQUIRED SUBMISSION DATE	DATE RECEIVED IN CONTRACTING	DATE TO MECHANICAL ENGINEERING	RETURN SUSPENSE DATE	SUBMITTAL NUMBERS	DATE CONTRACTOR NOTIFIED		CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
		STEEL CERTIFICATE OF COMPLIANCE	SHOP DRAWINGS	SCHEDULES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	CATALOG DATA	OPERATING INSTRUCTIONS	REPORTS	DELEGATED DESIGN						APPROVED	DIS-APPROVED			
13	236514.17 - Closed-Circuit, Induced-Draft, Combined-Flow Cooling Towers		5				5	5	5			NTP +10									A,B
14	238126 - Split-System Air-Conditioners		5					5				NTP +10									A,B
15	Various – Equipment Training, O&M Manuals						3		3												A,B
16	017839 – Hard Copy of As-Built Drawings									3											A,B
17	017839 – CDRom of As-Built Drawings in AutoCAD									3											A,B

A. No deviations, substitutions or changes of materials, to be incorporated into this project, shall be made after approval by the Department, except for written direction by and the approval of the manufacturer of a specific item and re-approval by the Department.

B. The Department retains the right to require additional items not specifically denoted to be submitted for approval and/or additional clarification.

SCHEDULE OF MATERIAL SUBMITTALS **PLUMBING (.3)**												PROJECT # **DMVA/BMCE-420591 (88821)**				PROJECT TITLE TISA 11-89 ENERGY UPGRADES				
TO BE COMPLETED BY PROJECT ENGINEER												TO BE COMPLETED BY CONTRACT ADMINISTRATOR								
LINE NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL	NUMBER OF COPIES REQUIRED										REQUIRED SUBMISSION DATE	DATE RECEIVED IN CONTRACTING	DATE TO MECHANICAL ENGINEERING	RETURN SUSPENSE DATE	SUBMITTAL NUMBERS	DATE CONTRACTOR NOTIFIED		CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
		STEEL CERTIFICATE OF COMPLIANCE	SHOP DRAWINGS	SCHEDULES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	CATALOG DATA	OPERATING INSTRUCTIONS	REPORTS	DELEGATED DESIGN						APPROVED	DIS-APPROVED			
1	220533 - Heat Tracing for Plumbing Piping		**5**				**5**	**5**	**5**			**NTP +30**									A,B
2	221110 – Plumbing Insulation							**5**				**NTP +30**									A,B
3	221110 – Domestic Water Piping							**5**				**NTP +30**									A,B
4	221110 – Domestic Water Piping Valves and Specialties (balancing, check, ball, arresters)							**5**				**NTP +30**									A,B
5	221110 – Sanitary Waste and Vent Piping							**5**				**NTP +30**									A,B
7	221310 – Sanitary Waste Piping Specialties (floor drains, cleanouts)							**5**				**NTP +30**									A,B
13	Various – O&M Manuals									**2**											A,B
14	017839 – Hard Copy of As-Built Drawings									**3**											A,B
15	017839 – CDRom of As-Built Drawings in AutoCAD format									**2**											A,B

A. No deviations, substitutions or changes of materials, to be incorporated into this project, shall be made after approval by the Department, except for written direction by and the approval of the manufacturer of a specific item and re-approval by the Department.

B. The Department retains the right to require additional items not specifically denoted to be submitted for approval and/or additional clarification.

SCHEDULE OF MATERIAL SUBMITTALS
Electrical Submittals *

PROJECT NUMBER
DMVA 420591(88821)

PROJECT TITLE
TISA 11-89 ENERGY UPGRADES

ITEM NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL	NUMBER OF COPIES REQUIRED											REQUIRED SUBMISSION DATE	DATE RECEIVED IN CONTRACTING	DATE TO ENGINEERING AND ARCHITECTURE	DATE TO CONTRACTING FROM E&A	DATE CONTRACTOR NOTIFIED				RESUBMITTAL				REMARKS
		CERTIFICATE OF COMPLIANCE	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	CATALOG DATA	OPERATING INSTRUCTIONS	REPORTS	BATCH SLIPS	STEEL CERTIFICATIONS					ACCEPTED	ACCEPTED AS NOTED	REVISE & RESUBMIT	NOT ACCEPTED	DATE OF RESUBMITTAL TO CONTRACTING	DATE OF RESUBMITTAL TO E&A	DATE OF RESUBMITTAL TO CONTRACTING FROM E&A	DATE OF FINAL APPROVAL	
1	260500 – Common Work Results for Electrical, Vibration Isolators	**5**						**5**					**NTP +10**												
2	260500 – Common Work Results for Electrical, Access Panels							**5**				**5**	**NTP +10**												
3	260500 – Common Work Results for Electrical, Concrete										**5**		**NTP +10**												
4	260519 – Low-Voltage Electrical Power Conductors & Cables, Conductors and Cables, and Connectors & Splices							**5**					**NTP +10**												
5	260526 – Grounding & Bonding for Electrical Systems, Grounding Conductors, Connectors, Grounding Electrodes, & Conduit Ground Bushings							**5**					**NTP +10**												
6	260529 – Hangers & Supports for Electrical Systems, Support, Anchorage & Attachment Components							**5**				**5**	**NTP +10**												
7	260533 – Raceway and Boxes for Electrical Systems, Metal Conduit and Tubing							**5**				**5**	**NTP +10**												
8	260533 – Raceway and Boxes for Electrical Systems, Boxes, Enclosures, Cabinets, and Sleeves for Raceway							**5**				**5**	**NTP +10**												
9	260553 – Identification for Electrical Systems, Identification Materials							**5**					**NTP +10**												
10	260573 – Overcurrent Protective Device Coordination Study									**5**			**NTP +30**												Submit after coordination with all distribution equipment.
11	261200 – Medium Voltage Transformers							**5**					**NTP +10**												
12	262213 – Low-Voltage Distribution Transformers							**5**					**NTP +30**												Submit after coordination with Overcurrent Protective Device Coordination Study

SCHEDULE OF MATERIAL SUBMITTALS
Electrical Submittals *

PROJECT NUMBER: **DMVA 420591(88821)**

PROJECT TITLE: TISA 11-89 ENERGY UPGRADES

ITEM NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL	NUMBER OF COPIES REQUIRED											REQUIRED SUBMISSION DATE	DATE RECEIVED IN CONTRACTING	DATE TO ENGINEERING AND ARCHITECTURE	DATE TO CONTRACTING FROM E&A	DATE CONTRACTOR NOTIFIED				RESUBMITTAL				REMARKS
		CERTIFICATE OF COMPLIANCE	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	CATALOG DATA	OPERATING INSTRUCTIONS	REPORTS	BATCH SLIPS	STEEL CERTIFICATIONS					ACCEPTED	ACCEPTED AS NOTED	REVISE & RESUBMIT	NOT ACCEPTED	DATE OF RESUBMITTAL TO CONTRACTING	DATE OF RESUBMITTAL TO E&A	DATE OF RESUBMITTAL TO CONTRACTING FROM E&A	DATE OF FINAL APPROVAL	
13	262416 – Panelboards		**5**					**5**				**5**	**NTP +30**												Submit after coordination with Overcurrent Protective Device Coordination Study
14	262713 – Electricity Metering							**5**					**NTP +10**												
15	262726 – Wiring Devices							**5**					**NTP +10**												
16	262813 – Fuses					**5**		**5**					**NTP +30**												Submit after coordination with Overcurrent Protective Device Coordination Study
17	262913 – Enclosed Controllers		**5**			**5**		**5**				**5**	**NTP +10**												Submit after coordination with Overcurrent Protective Device Coordination Study
18	263100 – Photovoltaic Collectors		**5**					**5**				**5**	**NTP +10**												
19	265100 – Interior Lighting		**5**					**5**				**5**	**NTP +10**												

* NOTE: This form is provided for contract compliance and does not alleviate any requirements stated in the specifications. "NTP" – Notice to Proceed. Combine submittals where appropriate, line items are shown for control only.

SECTION 014000

QUALITY CONTROL REQUIREMENTS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by the Department of Military and Veterans’ Affairs or authorities having jurisdiction are not limited by provisions of this Section.
4. Specific test and inspection requirements are not specified in this Section.

1.4 DEFINITIONS

A. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Government Design Professionals. All Quality Control Services shall be at the Contractor's cost, which shall be included proportionally in all items of payment or contained in any Base Bid or Unit Price on the Proposal.

B. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

C. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

D. Source Quality-Control Testing: Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.

E. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

F. Testing Agency: An entity engaged by the contractor to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

G. Government Required Inspections: All inspections deemed necessary per the DMVA Inspection Form, will require oversight and verification by DMVA-Bureau of Design and Project Management personnel.

H. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

I. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.5 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to the Government Design Professional(s) for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Government Design Professional(s) for a decision before proceeding.

1.6 TESTING SUBMITTALS

A. Schedule of Tests: Testing submittals shall include the following:

1. Specification Section number and title.
2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within ten (10) days of Notice to Proceed, and not less than five (5) days prior to preconstruction conference. Submit in format acceptable to Government Design Professional. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

1. Project quality-control manager may also serve as Project superintendent.

C. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests including subcontractor-performed tests. Include required tests and inspections and Contractor-elected tests and inspections.

D. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

E. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Government Design Professional and/or Project Manager has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.

5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of technical representatives making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

D. Permits, Licenses, and Certificates: For Government’s records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.9 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

F. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

1. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Government Design Professional, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

1.10 QUALITY CONTROL

A. Government Responsibilities: Where quality-control services are indicated as Government’s responsibility, the Government will engage qualified Government personnel and/or an independent testing agency to perform these services.

1. Government will furnish Contractor with names, addresses, and telephone numbers of personnel or testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.

B. Contractor Responsibilities: All testing requirements outlined within the Project Design Documents and/or requested by the Government Project Representatives, are to be the Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

a. Contractor shall not employ same entity engaged by the Government, unless agreed to in writing by Government.

2. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
3. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
4. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. Retesting/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction work that failed to comply with the Contract Documents.

F. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

1.11 TESTS AND INSPECTION PROCEDURES

A. Required Tests: Contractors shall refer to the Project Specifications for all testing requirements pertaining to individual aspects of the project.

B. Notification of Inspections and Tests: Contractor shall notify the DMVA-BDPM Project Manager of a required or specified inspection and/or inform them of an upcoming test. Contractor shall refer to the DMVA Inspection Log for the required allowance of notification (in business days) for requesting inspections and/or observations of tests.

1. Notification of required inspections or tests shall not be less than 48 hours prior to the inspection and/or test. Weekends and Observed Government Holidays shall not be factored into notifications and are not considered as business days.

C. Upon the completion of an inspection or test. The Government Design Professional or Project Manager will approve or dis-approve the work in question and sign and date the Inspection Log within forty-eight (48) hours of the test or inspection being completed.

D. At no time shall any work of any type outlined within the DMVA Inspection Log be covered-up or concealed from view until all required inspections and/or tests have been conducted and the Department has approved it.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials that comply with installation requirements specified in corresponding Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams, that show no visible signs of damage or repair.

B. Protect construction exposed by or for quality-control service activities.

C. In the event of work being deemed unacceptable due to poor workmanship, code violations, failure to meet design intent or following of the design documents, etc., corrective actions will be provided to the contractor along with a timeframe in which the contractor will have to complete the corrective actions. Communication to the contractor(s) regarding corrective actions will be in the form of meeting minute comments and/or formal (email or written) correspondence provided by the Government Contracting Office.

D. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

E. Failure of the contractor to correct work of any type deemed to be unacceptable, could result in the Government taking actions as outlined within the Project General Conditions.

END OF SECTION

DMVA - BUREAU OF DESIGN AND PROJECT MANAGEMENT
INTERNATIONAL BUILDING CODE INSPECTION LOG

Project Name: Project No. 420591(88821) Bldg. 11-89 TISA, Energy Upgrades
Project Location: Area 11, Ft. Indiantoen Gap, Annville, PA 17003

Project Manager: Dan Conley
Phone Number: 717-376-5932
Email: daconley@pa.gov

REQ.	INSPECTION	NOTICE (Business Days)	DEPARTMENT REPRESENTATIVE (SIGNATURE)	DATE ACCEPTED
☑	Demolition	72 hours		
☐	Footer Environment	48 hours		
☑	Underground Mechanical	72 hours		
☑	Underground/Overhead Electrical	72 hours		
☑	Underground Plumbing	72 hours		
☑	Foundation	48 hours		
☑	Under-Slab Mechanical	72 hours		
☑	Under-Slab Electrical	72 hours		
☑	Under-Slab Plumbing	72 hours		
☐	Concrete Under Slab/Floor	48 hours		
☑	Exterior Wall Construction	48 hours		
☑	Mechanical Rough-In	72 hours		
☑	Electrical Rough-In	72 hours		
☑	Plumbing Rough-In	72 hours		
☑	Framing (Interior)	48 hours		
☑	Insulation (Interior)	48 hours		
☐	Roofing:	-		
☐	a) Exposed Roof Substrate	72 hours		
☐	b) Insulation	72 hours		
☐	c) Membrane	72 hours		
☐	d) Metal Trim & Flashing	72 hours		
☐	e) Gutter and Downspout	72 hours		
☐	f) Final Completion of Roof	72 hours		
☑	Fire Protection	72 hours		
☐	Asphalt/Concrete Paving	72 hours		
☑	Final - Mechanical	5 days		
☑	Final - Electrical	5 days		
☑	Final - Plumbing	5 days		
☑	Final - Building	5 days		
☑	Final - Site/Grading	5 days		
☑	Final - E&S Control Features	5 days		
☑	Final - Site Improvements	5 days		

NO WORK MAY BE CONCEALED FROM VIEW, UNTIL THE DEPARTMENT HAS APPROVED IT.

Pennsylvania Department of Military & Veterans' Affairs
Bureau of Design & Project Management

INSPECTION PROCEDURES

1. **Footing Inspection**: Is to be performed after footing is dug with chairs and rods in place before concrete is poured.

2. **Underground/Overhead M.E.P Inspection**: All underground mechanical, electrical and plumbing trenching must be open and all piping, sleeves and/or conduit required for underground utilities shall be in place and provided with rodent-proofing.

3. **Foundation Inspection**: Is to be performed before framing work begins or backfill is placed. Grease traps, cleanouts, foundation and roof drains must be in place. Foundation coating must be applied, anchor bolts and top plates shall be installed. Post-pour footing inspection shall be conducted at this time and shall include verification of the depth of the footing, continuity of the footing, width of the footing and determining if the top of the footing is level.

   Note: Foundation inspection will not be approved until the plumbing, electrical and HVAC underground work has been approved by the Department.

4. **Under-Slab M.E.P. Inspection**: Shall be performed after any/all plumbing piping, mechanical piping and electrical conduit has been placed and properly sealed and tested. Required pressure testing of plumbing and HVAC piping shall be completed prior to the Under-Slab Inspection.

5. **Under-Slab Inspection**: Is to be performed prior to the pouring of the concrete and after the base course or sub-base is properly prepared, the vapor barrier (if required) is in place and reinforcing materials such as rebar or wire mesh is properly positioned.

6. **Exterior Wall Inspection**: Is to be performed after exterior perimeter walls (concrete, CMU, steel framing, etc.) have been erected. Top plates, bracing, lintels, spray-applied vapor/moisture barriers (if required) and rigid wall insulation shall all be installed prior to the inspection being conducted. Inspection shall be performed prior to the installation of interior framing and M.E.P. rough-ins.

7. **Electrical Rough-In Inspection**: Is to be performed after the roof, framing, fire blocking and bracing are in place and all wiring and other components to concealed are complete. This inspection is required prior the installation of wall and ceiling finishes.

8. **Plumbing Rough-In Inspection**: Is to be performed after the roof, framing, fire-blocking, fire-stopping, draft stopping, and bracing are in place and all sanitary, storm and domestic water piping is roughed-in. This inspection is required prior to the installation of wall and ceiling finishes.

9. **Mechanical Rough-In Inspection**: Is to be performed after the roof, framing, fire-blocking and bracing are in place and all ducting and other components to be concealed are complete. This inspection is required prior to the installation of wall and ceiling finishes.

10. **Framing Inspection**: Is to be performed before insulation is installed and after all plumbing, electrical and mechanical rough-in work is completed and inspected.

    Note: The framing may not be approved until all plumbing, electrical and HVAC rough-in work has been approved by the Department.

11. **Insulation Inspection**: Is to be performed after the framing work is approved by the Department and all insulation materials have been installed. This inspection is required prior to the installation of wall and ceiling finishes.

12. **Fire Protection Systems Inspection**: Is to be performed after fire alarm systems and/or fire suppression systems are installed and functioning. The Department has the option to accept installation and test certificates from the installing contractor(s) in lieu of witnessing the testing of fire protection systems.

13. **Final Electrical Inspection**: Is to be performed after all electrical work in the building has been completed.

14. **Final Mechanical Inspection**: Is to be performed after all HVAC work in the building has been completed.

15. **Final Plumbing Inspection**: Is to be performed after all plumbing work in the building has been completed.

16. **Final Building Inspection**: Is to be performed after all items contained within the project design documents have been completed and all prior inspections have been completed and approved. These items include, but are not limited to:

    a. General Building:

    - Interior and Exterior Finishes
    - Roofing Materials/Flashing
    - Egress
    - Accessibility (including site)
    - Final Grading
    - Site Plan Compliance – Erosion & Sediment Control Measures

    b. Electrical Work
    c. Plumbing Work
    d. Mechanical Work
    e. Fire Protection Systems
    f. Energy Conservation

17. **Department of Military & Veterans' Affairs (DoD) Special Inspections**: Certain facility types and specific components of the facility, may require additional inspections prior to the final acceptance of the facility by the Department. Components such as, but not limited to; weapons vaults, security monitoring, fuel distribution and/or storage, vehicle maintenance exhaust systems and secure communication rooms all may require special inspections. If not outlined within the project documents, the Department will notify contractors of any special inspections prior to the start of construction.

18. **Demolition Inspections**: Contractors responsible for demolition work where an entire structure is razed will be required to submit signed documentation that certifies that the vacant lot is filled to existing grade and that all service connections have been disconnected and properly capped. Demolition work being performed on an existing as part of renovation work or the erection of an addition may be subject to inspection by the Department. Contractors must ensure that pedestrian protective measures have been installed prior to the commencing of demolition work. Contractor shall not negatively impact existing means of egress until alternative egress routes have been established and approved.

NOTES

1. Contractors may not be subject to all the inspections as outlined herein. Contractors shall refer to the attached DMVA Inspection Form for all required inspections pertaining to a specific project.

2. Contractor shall contact the DMVA Project Manager and Government Design Professional prior to any and all required inspections. The DMVA Inspection Form includes required notification timeframes for each required inspection. These notifications shall be considered business days and not include weekends and/or observed Government Holidays.

3. The DMVA Inspection Procedures along with the DMVA Inspection Log, must be retained at the construction site until the completion of all work and must be made available to all Department Representatives upon request.

4. **At no time shall work of any type be concealed from view, until all required inspections have been conducted and the Department has approved it.**

SECTION 016350

DEPTARTMENT OF MILITARY & VETERANS AFFAIRS

SUPPLEMENTAL PROVISIONS

PART 1 – GENERAL

1.1 STIPULATIONS

A. The specifications "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 PERSONAL BEHAVIOR

A. Contractors are responsible for informing their employees of the special restrictions on personal behavior and the procedures/potential penalties for violations.

B. Identification tags or badges to be furnished by the Project Manager must be worn at all times while on facility property.

C. Smoking is not permitted in any facility.

1.4 WORKING HOURS

A. Refer to specification Section 011200 "Coordination & Control", for working hours. Any extension outside of these hours must be accomplished in accordance with the General Conditions and with the consent of both the Department and Institution Manager.

1.5 VEHICLES

A. Construction vehicles, as well as employees' vehicles, will be parked in an area designated by the Project Manager and Department and locked at all times. If any vehicles are to be left overnight, the license number or numbers of vehicles must be reported to the Project Manager daily.

1.6 TOOLS

A. Tools shall be kept in a secure (locked) area when not in use and inventoried daily to ensure complete and total accountability. While the tools are being used, they shall be kept in view or on person. Broken or non-usable tools are to be disposed of away from Institutional property.

1.7 FRATERNIZATION

A. There shall be no fraternization or private relationships of Contractors' employees with residents and Institution Staff. This includes, but is not limited to, trading, bartering or receiving gifts, money, favors from the residents, or the residents' friends, relatives or representatives.

1.8 ALCOHOL AND CONTROLLED SUBSTANCES

A. Alcoholic beverages and controlled substances shall not be carried, stored, or consumed on Department property nor left in any vehicle.

1.9 SECURITY REQUIREMENTS

A. General Personnel Register

1. Contractor shall be responsible for creating, updating and revising a typed list of all employees on site, along with a copy of each individual's photo identification. This information shall also include any and all sub-contractors. The list and copies of identification will be revised and updated as construction progresses. A copy of the list and copies of identification shall be provided to the DMVA Project Manager, listed in Section 010400-1.4. Contractors shall provide their initial list of employees to the Project Manager at the pre-construction conference. All future updates to the initial list, to include photo identifications should be delivered to the Project manager at least three (3) days prior to those individuals entering the project site.

B. Fort Indiantown Gap Access

1. Currently access to Fort Indiantown Gap (FTIG) is restricted. There is one gate (Main Gate) and access point for all contractors, delivery drivers, and vendors to enter Fort Indiantown Gap (FTIG) and it is located at the West end of FTIG. The Main Gate is located on SR934 directly after passing the National Cemetery, which can be accessed from Exit 85 on Interstate 81 (Exit 85B if traveling northbound). Delivery and contractor vehicles must utilize the "Truck Lanes" for access and an official state or federal photo identification will be required. All personnel entering the FTIG Main Gate will be required to stop at the Visitors Center to attain a background check using the FBI's National Crime Information Center Interstate Identification Index (NCIC-III) to obtain access. The visitor center is located with the Main Gate and will be open during business hours. Contractors requiring multi-day, multi-month, or yearlong access to complete projects or perform service work

should enter the visitors center to get information about work crew access or acquiring extended access (AIE) badges.

2. Contractors coming to FTIG for a site visit or that will only be on site for a limited time will be required to stop at the visitor's center and obtain a 24 hour or short term pass.

3. All contractors, contractor personnel, delivery drivers, and subcontractors will need to know the purpose of their visit to FTIG and the building number they are visiting (if applicable) to obtain an access (AIE) badge or a 24 hour pass. It is the contractor's responsibility to ensure that subcontractors and delivery personnel have the information necessary to gain access to FTIG.

4. Once personnel have an AIE badge, they will not need to provide additional information regarding the reason for visit or worksite when entering the gate/truck lane. All contractors that receive an access (AIE) badge will not need to show additional ID at the gate/truck lane.

5. All contractor vehicles that include covered or closed beds, boxes, or compartments must proceed to the truck lane for inspection, this includes tractor trailers, work vans, delivery vans, box trucks, work trucks with multiple compartments, and pickup trucks with covered beds. If the truck lane is not open, the trucks will be checked at the regular checkpoint lanes. If the vehicle is under 5 tons and the operator possesses a long term AIE badge the vehicle will not require inspection at this time.

6. This guidance is subject to change with changes in the Force Protection Condition (FPCON) or operational tempo or variables.

END OF SECTION

SECTION 017700

CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Inspection procedures.
2. Warranties.
3. Final cleaning.

B. Related Sections include the following:

1. Division 1 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
2. Division 1 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
3. Divisions 2 through 33 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

1.4 SUBSTANTIAL COMPLETION (BENEFICAL OCCUPANCY)

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.

1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
2. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
3. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction, damage or settlement surveys, property surveys, and

similar final record information.

4. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
5. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
6. Complete startup testing of systems.
7. Submit test/adjust/balance records.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Advise Owner of changeover in heat and other utilities.
10. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
11. Complete final cleaning requirements, including touchup painting.
12. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Government Design Professional and Government Inspector will either proceed with inspection or notify Contractor of unfulfilled requirements. The Contracting Officer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Design Professional and/or Inspector, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.5 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment according to the Government Contracting Office’s "Payment Procedures."
2. Submit certified copy of Government Design Professional's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by the Design Professional. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.
4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Government Design Professional and Inspector will either proceed with inspection or notify Contractor of unfulfilled requirements. The Contracting Officer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.6 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first then proceeding on the interior from the Main Entrance clockwise throughout the facility.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

a. Project name.
b. Date
c. Name of Contractor.
d. Page number.

1.7 WARRANTIES

A. Submittal Time: Submit written warranties on request of the Government Design Professional (per FORM 66's) for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.

B. Organize warranty documents within the Project Operation and Maintenance Manuals.

PART 2 - EXECUTION

2.1 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
d. Remove tools, construction equipment, machinery, and surplus material from Project site.
e. Remove snow and ice to provide safe access to building.
f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
h. Sweep concrete floors broom clean in unoccupied spaces.
i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
k. Remove labels that are not permanent.
l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

    1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
n. Replace parts subject to unusual operating conditions.
o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
q. Clean ducts, blowers, and coils if units were operated without filters during construction.
r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
s. Leave Project clean and ready for occupancy.

C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

PART 3 - PRODUCTS

3.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

END OF SECTION

SECTION 017823

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, and “Special Conditions”, and “Division 1 - General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

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

1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Operation manuals for systems, sub-systems, and equipment.
4. Maintenance manuals for the care and maintenance of products, materials, finishes, systems and equipment.

B. Related Sections include the following:

1. Division 1 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
2. Division 1 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
3. Divisions 2 through 33 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.4 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.

1.5 SUBMITTALS

A. Final Submittal: Submit one copy of each manual in final form at least 14 days before final inspection. Government Design Professional will return copy with comments within 7 days after final inspection.

1. Correct or modify each manual to comply with Design Professional's comments. Submit 3 copies of each corrected manual within 7 days of receipt of Design Professional's comments.

1.6 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 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Organization: Include a section in the directory for each of the following:

1. List of documents.
2. List of systems.
3. List of equipment.
4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

2.2 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each 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: Enclose title page in transparent plastic sleeve. Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Date of submittal.
4. Name, address, and telephone number of Contractor.
5. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project 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.

D. Manual Contents: Organize into sets of manageable size. Arrange contents per CSI Specifications (Divisions 2-16). Within each organize each Division 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, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
   a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
   b. Identify each binder on front and 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, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch (215-by-280-mm) white bond paper.
5. 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.
   b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.3 EMERGENCY INFORMATION

A. Content: Organize into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

2.4 OPERATION INFORMATION

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions.
2. Operating standards.
3. Operating procedures.
4. Operating logs.
5. Wiring diagrams.
6. Control diagrams.
7. Piped system diagrams.
8. Precautions against improper use.
9. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.

7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.5 PRODUCT MAINTENANCE

A. Content: Organize into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in 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, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE INFORMATION

A. Content: For each system, subsystem, and 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 and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in 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, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard printed maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training videotape, if available.

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 with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance information.

B. Emergency Informationl: Compile complete documantation of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.

C. Product Maintenance Information: Compile complete documentation of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

D. Operation and Maintenance Information: Compile complete documentation of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

E. 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. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.

1. Do not use original Project Record Documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared Record Drawings in Division 1 Section "Project Record Documents."

END OF SECTION

SECTION 017839

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:

1. Record Drawings in CAD Format.
2. Record Specifications.
3. Record Product Data.
4. Project Cost Analysis

B. Related Sections include the following:

1. Division 1 Section "Closeout Procedures" for general closeout procedures.
2. Division 1 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
3. Divisions 2 through 33 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.4 SUBMITTALS

A. Record Drawings: Comply with the following:

1. One (1) Hard Copy of Contractor As-Built Drawings. Drawing Size to be 30”x42”.
2. One (1) CDRom containing CAD based Contractor As-Built Drawings.

B. Record Product Data: Submit as part of the Project Operation and Maintenance Manuals.

C. Project Cost Analysis: To be submitted when the Owner takes Benefical Occupancy.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Contractor to maintain one (1) red-lined set of drawings throughout the duration of the project construction phase. Prior to the substantial completion, contractor shall transfer all red-lined mark-ups to the Government provided CAD drawings.

1. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations below first floor.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Change Order or No Cost Field Change.
k. Changes made following Government Design Professional's written orders.
l. Field records for variable and concealed conditions.

B. Preparation: Contractor to transfer all construction red-line mark-ups from the record set onto the Government provided CAD drawings. Government drawings are AutoDesk (AutoCad) format and this format shall be maintained by the contractor.

1. Contractor to create a CAD layer within each Government provided CAD drawing and label it;
"CONTR_AS-BUILTS"
Note: All contractor related As-Built changes shall be contained to this layer.

C. Paragraph and subparagraphs below describe a procedure for assembling nearly correct reproducible Drawings. Add requirements for special printing methods on specific material, such as moisture-sensitive prints on mylar film. Delete if not required.

D. Record Plans: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Government Design Professional and/or Contracting Officer. When authorized, prepare a full set of corrected transparencies of the Contract Drawings and Shop Drawings.

1. Refer instances of uncertainty to the Government Design Professional for resolution.

E. Format:

1. Record Prints: Contractor shall plot one (1) 24"x36" (min.) set of As-Built drawings to submit for review. As-Built set shall be organized and binded per the DMVA-BMCE Cover Sheet. Hardcopy set should contain an "AS-BUILT" stamp located in the lower right-hand corner of each sheet.
2. AutoDesk (AutoCad) Format, Release 2004 (or newer).

2.2 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, Specifications and Record Drawings where applicable.

2.3 PROJECT COST ANALYSIS

A. Preparation: Contractor shall maintain construction cost throughout the duration of the project. The following cost shall be submitted upon the Owner taking Benefical Occupancy of the facility.

B. Building Cost: Overall construction cost of the facility, excluding all site utilities. Cost shall incorporate all Change Order amounts into this breakout.

C. Site Utilities: Contractor shall provide an updated cost and total linear footage for the following site utility installations:

1. Domestic Water
2. Sanitary Sewer
3. Electrical Service
4. Gas/Propane Service

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submit in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Government Design Professional, Government Inspector and/or

Contracting Officer's reference during normal working hours.

END OF SECTION

SECTION 024116

DEMOLITION

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Demolition and removal of building features, interior finishes, site improvements, etc.

B. Related Sections:

1. Division 01 Section "Summary" for use of the premises and phasing requirements.
2. Division 01 Section “Cutting and Patching” for cutting and patching procedures.

1.4 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.

B. Existing to Remain (ETR): Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, salvaged or reinstalled.

1.5 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.6 SUBMITTALS

A. Qualification Data: For qualified refrigerant recovery technician.

B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

C. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's building manager's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of stairs.
5. Locations of proposed dust- and noise-control temporary partitions and means of egress, including for other tenants affected by selective demolition operations.
6. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
7. Means of protection for items to remain and items in path of waste removal from building.

D. Inventory: After selective demolition is complete, submit a list of items that have been removed and salvaged.

1.7 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project.

C. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

D. Pre-demolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be demolished.
2. Review structural load limitations of existing structures.
3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review and finalize protection requirements.
5. Review procedures for protection of adjacent buildings.
6. Review items to be salvaged and returned to Owner.

1.8 PROJECT CONDITIONS

A. All areas slated to be demolished will be vacated and their use discontinued before start of the Work.

B. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.

C. Owner assumes no responsibility for building features and structures to be demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
2. Before demolition, Owner will remove the following items:

a. Any and all unit equipment, historical & unit memorabilia, office furniture and office equipment currently be stored within the existing facility.
b. Owner will require a minimum of 5 business days notice prior to the start of any demolition work.

D. Hazardous Materials: No known asbestos containing materials.

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

F. Storage or sale of removed items or materials on-site is not permitted.

1.9 COORDINATION

A. Arrange demolition schedule so as to minimize interference with Owner's on-site operations or operations of adjacent occupied buildings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting demolition operations.

B. Review Project Record Documents, if any, of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform a pre-demolition survey of existing building conditions to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during the demolition operations.

D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

E. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Government Design Professional.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems: Maintain services/systems indicated to remain and protect them against damage during selective demolition operations.

B. Service/System Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Building manager will arrange to shut off indicated services/systems when requested by Contractor.
2. If services/systems are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

3.3 PREPARATION/PROTECTION

A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

B. Existing Utilities: See Divisions 22 and 26 Sections for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

C. Existing Facilities: Protect adjacent walkways, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.

D. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of demolition.

E. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent areas of the facility to remain.

1. Provide protection to ensure safe passage of people around demolition area and to and from occupied portions of building.

2. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during demolition operations.
3. Cover and protect furniture, furnishings, and equipment that have not been removed.

F. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

G. Salvaged Items: Comply with the following:

1. Clean salvaged items of dirt and demolition debris.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to storage area designated by Owner.
5. Protect items from damage during transport and storage.

3.4 DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
4. Maintain adequate ventilation when using cutting torches.
5. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
6. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
7. Dispose of demolished items and materials promptly. Comply with requirements in Division 01 Section "Construction Waste Management and Disposal."

B. Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.

C. Explosives: Use of explosives is not permitted.

3.5 DEMOLITION BY MECHANICAL MEANS

A. Proceed with demolition of structural framing members systematically, from higher to lower level.

B. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

1. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.

C. Below-Grade Construction: Existing foundation walls and other below-grade construction shall remain in-place and disturbance kept to a minimum throughout the demolition phase.

D. Existing Utilities: Refer to Electrical, HVAC and Plumbing design documents for requirements regarding all existing utilities.

3.6 SITE RESTORATION

A. Prepare site and adjacent areas in accordance with all new construction outlined within the Project Design Documents.

3.7 REPAIRS

A. Promptly repair damage to adjacent areas/surfaces caused by demolition operations.

B. Existing Slab: Contractor shall repair any and all damage to the concrete slab prior to the beginning of new construction aspects.

3.8 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and legally dispose of them in an EPA-approved landfill acceptable to authorities having jurisdiction. See Division 01 Section "Construction Waste Management and Disposal" for recycling and disposal of demolition waste.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Do not burn demolished materials.

3.9 CLEANING

A. Clean adjacent areas, surfaces and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before demolition operations began. Areas that will involve additional demolition operations should be cleaned only to the point that will allow for further work to be conducted in a safe manner.

1. Clean roadways of debris caused by debris transport.

END OF SECTION

SECTION 024120

CUTTING AND PATCHING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:

1. Division 02 Section "Selective Structure Demolition" for demolition of selected portions of the building.
2. Divisions 02 through 49 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

1.4 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.5 SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 5 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.

2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
3. Products: List products to be used and firms or entities that will perform the Work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
6. Facility Construction Maintenance Manager's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.6 QUALITY ASSURANCE

A. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:

1. Equipment supports.
2. Piping.

B. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Government Design Professional’s opinion, reduce the building's aesthetic qualities.

PART 2 - PRODUCTS

2.1 MATERIALS

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

B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
5. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as

possible. Provide materials and comply with installation requirements specified in other Sections.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

    a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

    a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather-tight condition.

D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions of the Construction Contract," "Special Conditions," and "Division 1 – General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. This Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation Walls.
3. Slab-on-grade.
4. Stoops.
5. Curbs.

1.3 REFERENCES/ACRONYMS

A. The following referenced material shall apply to this specification and have the sameforce and effect as if printed in full herein:
1. ACI = American Concrete Institute
2. CRSI = Concrete Reinforcing Steel Institute
3. ASTM = American Society of Testing and Materials
4. PennDOT = Pennsylvania Department of Transportation

ACI 301-89	Specifications for Structural Concrete for Buildings.
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347	Recommended Practice for Concrete Formwork
ACI 304	Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 302	Recommended Practice for Concrete Floor and Slab Construction
ACI 315	Detail Manual
ACI 308	Standard Practice for Curing Concrete
CRSI	Manual of Standard Practice
CRSI	Recommended Practice for Placing Reinforcing Bars
PennDOT	Publication 408 (latest edition) with supplements
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM C 150	Specification for Portland Cement

ASTM A 497	Standard Specification for Steel Welded Fabric, Deformed for Concrete Reinforcement
ASTM A 185	Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615 A 615M	Standard Specification for Deformed and Plain Billet Steel bars for Concrete Reinforcement
ASTM C 260	Standard Specification for Air-Entrained Admixtures for Concrete
ASTM C 309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

1.4 SUBMITTALS

A. Make submissions in accordance with Division 1 Specifications and 'SCHEDULE OF MATERIAL SUBMITTALS', attached at the end of the Specifications.

B. No deviations, substitutions or changes of materials, to be incorporated into this project, shall be made after approval by the Department, except for written direction by and the approval of the manufacturer of a specific item and re-approval by the Department.

C. The Department retains the right to require additional items not specifically denoted to be submitted for approval and/or additional clarification.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Only concrete obtained from PennDOT approved/certified batch plant shall be used in conjunction with this project.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Prior to each pour, contractor shall provide a Concrete Plant Batch Slip for each batch utilized for the given pour. The Batch Slip shall be submitted to the Inspector by the first delivery truck for each batch. The Batch Slip shall contain the following information (at a minimum):

1. Date.
2. Plant Name and Location.
3. Batch Number.

4. Batch Time.
5. Dry materials and weights.
6. Liquids and volumes.
7. Admixtures and volumes.

F. Prior to the starting of a pour, concrete delivery drivers shall provide the on-site Inspector with a delivery slip. Delivery slips shall denote the following information:

1. Truck No., Driver's Name, and Batch Plant.
2. Time stamp for batch and/or time driver left plant.
3. Concrete Mix.
4. Batch Slump.
5. Admixtures.
6. Time Mixer arrived at Site.

Note: At no time will a driver be granted permission to off-load if a valid delivery slip is not provided.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

    a. High-density overlay, Class 1 or better.
    b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    c. Structural 1, B-B or better; mill oiled and edge sealed.
    d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, Bollards and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

H. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive damp proofing or waterproofing.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.

D. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from galvanized-steel wire into flat sheets.

E. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884, Class A coated, Type 1, steel wire, with less than 2 percent damaged coating in each 12-inch wire length. (Exterior locations).

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated. (Exterior locations)

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follow:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I, gray. Supplement with the following:

a. Fly Ash: ASTM C 618, Class F.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, graded.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M.

2.5 ADMIXTURES

A. No admixtures will be permitted without prior notification and approval of the Design Professional and/or Inspector.

B. Air-Entraining Admixture: ASTM C 260.

C. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.6 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.7 FLOOR AND SLAB TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTMO M 182, Class2, burlap cloth made from jute or kenaf, weighing approx. 9oz./sq.yd. when dry.

C. Moisture Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable (It shall be the contractors responsibility to verify availability of potable water. If potable water is NOT available at project site, contractor will be responsible for providing water tanks).

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating. Maximum VOC emission of 350 g/L or less. Product shall not interfere with bonding of floor covering where used.

2.9 RELATED MATERIALS

A. Contraction Joint (C.J.)

1. Preformed two-piece plastic strip with a depth of 2”.
2. Manufacturer/Catalog Number: W.R. Meadows Sealtight catalog #324, Speed-E-Joint.

B. Keyed Construction Joint (K.C.J.)

1. ¼” wide by the full thickness of concrete slab asphaltic type with centered key having pre-punched openings at 24”o.c. for steel stakes. Stakes shall be minimum 18 gauge steel, 3/8” channel type by 15” long.
2. Manufacturer/Catalog Number: W.R. Meadows Sealtight catalog #321, Premoulded Tongue and Groove Joint.

C. Expansion Joint (E.J./E.E.J.)

1. ½” wide by the full thickness of concrete slab, asphaltic self-sealing type and shall conform to ASTM D 994.

2. Manufacturer/Catalog Number: W.R. Meadows Sealtight catalog #320 Asphaltic Expansion Joint.

2.10 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:

1. Fly Ash: 25 percent.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
2. Use water-reducing, high range water-reducing or plasticizing admixture in concrete as required for placement and workability.
3. Use water-reducing and retarding admixture when required by high temperature. Low humidity or other adverse placement conditions.
4. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structural slabs, concrete required to be watertight and concrete with a water-cementitious materials ratio below .50.

2.11 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Cementitious Materials Content: 0.45.
3. Slump Limit: 4 inches plus or minus 1 inch.

B. Foundation Walls, Grade Beams, Column Piers: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Cementitious Materials Content: 0.45.
3. Slump Limit: 4 inches plus or minus 1 inch.
4. Air Content: When determined necessary, 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

C. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 3500 psi at 28 days.

2. Maximum Cementitious Materials Content: 0.50.
3. Slump Limit: 4 inches plus or minus 1 inch.
4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

D. Sidewalks:

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Maximum Cementitious Materials Content: 0.45.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

2.12 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class C, 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Do not chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Inspector.

3.4 VAPOR RETARDERS

A. Plastic Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.5 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.6 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls at underside of slabs and at the top of footings or floor slabs.
5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

6. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

E. Waterstops: Install in construction joints and at other joints indicated according to manufacturer's written instructions.

3.7 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete. Contractor shall contact the Government Inspector at least 24 hours prior to a pour to schedule all necessary inspections. Contractor shall not proceed with a concrete pour without the knowledge of the Inspector and/or Design Professional.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Inspector and/or Design Professional.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 and only under supervision of the on-site Inspector.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time

necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.8 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.9 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated.

C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, and ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.

D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces approved for “broom” finish by the Design Professional. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

3.10 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.11 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-for spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-in lap over adjacent absorptive covers

2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer’s written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
3. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer, unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

3.12 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

3.13 CONCRETE SURFACE REPAIRS

A. General Note: It will be at the Inspector's or Design Professional's discretion to request the repair of an area due to damage and/or flaws in materials or installation. A repair will only be granted to areas smaller than 100 sf. Areas in excess of 100 sf. will be evaluated by the Government and determined if necessary to completely remove and replace the defective area. At no time will the cost of repair and/or replacement be the burden of the Government.

B. Defective Concrete: Repair and patch defective areas when approved by the Government. Remove and replace concrete that cannot be repaired and patched to Government's approval.

C. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

E. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, pop outs, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's

written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.

5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

F. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

3.14 FIELD QUALITY CONTROL

A. Testing and Inspecting: Contractor shall engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Contractor shall notify the Inspector and/or Design Professional at least 24 hours prior to a concrete pour. The Government Inspector will provide an inspection of the pour area and determine if all aspects are suitable for the pouring of concrete. The following is a lists of items that will be included in the Government's Pre-Pour Inspection:

1. Steel Reinforcement Placement (Rebar and/or Welded Wire Fabric).
2. Reinforcement Welds
3. Headed Bolts
4. Forms
5. Stone Base (Thickness and Compaction)
6. Pour area is clear of all foreign materials, water, mud, etc.
7. Verification of Design Mix
8. Approval of placement procedure.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Testing Frequency: It shall be at the discretion and right of the On-Site Government Inspector to request testing at closer intervals based on visible inconsistencies in product and/or climate conditions.
4. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
5. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
6. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.

   Compression Test Specimens: ASTM C 31/C 31M.

   a. Cast and laboratory cure tow sets of two standard cylinder specimens for each composite sample.
   b. Cast and field cure one set of two standard cylinder specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

   a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
   b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
10. Test results shall be reported in writing to the Inspector, Design Professional, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Inspector but will not be used as sole basis for approval or rejection of concrete.
12. Additional Tests: Testing agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing agency may conduct tests to determine

adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by the Inspector.

13. Additional testing at Contractor's expense will be performed to determine compliance of replaced or additional work with specified requirements.
14. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

END OF SECTION

SECTION 042000

UNIT MASONRY

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract,” “Special Conditions,” and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Concrete Masonry Units
2. Mortar and grout.
3. Reinforcing steel.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Embedded flashing.
7. Miscellaneous masonry accessories.

B. Related Sections:

1. Division 07 Section “Division 7 Section "Joint Sealants" for sealing control and expansion joints in unit masonry.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For the following:

1. Small-Scale Samples of each different block style, to include manufacturer’s full range of color selections.
2. Colored mortar.

C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.
2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

D. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

E. Anchors, Ties and Reinforcing.

1.5 QUALITY ASSURANCE

A. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

D. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that comes in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners, unless otherwise indicated.

B. Hollow Concrete Masonry Units: complying with ASTM C 90.

1. Weight Classification: Normal weight.
2. Size: As depicted on Contract Design Documents.
3. Colors and Patterns: As selected by Government Design Professional from manufacturer's full range.

2.3 MORTAR AND GROUT MATERIALS

A. Regional Materials: Provide aggregate for mortar and grout, cement, and lime that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

C. Hydrated Lime: ASTM C 207, Type S.

D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

E. Masonry Cement: ASTM C 91.

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

G. Colored Cement Product: Packaged blend made from masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Formulate blend as required to produce color indicated or, if no indicated, as selected from manufacturer’s standard colors.
2. Pigments shall not exceed 10 percent of Portland cement by weight.
3. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.

H. Aggregate for Mortar: ASTM C 144.

1. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
2. White-Mortar Aggregates: Natural white sand or crushed white stone.
3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

I. Aggregate for Grout: ASTM C 404.

J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

K. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.

L. Water: Potable.

2.4 REINFORCEMENT

A. Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60. (Size and locations per Project Structural Design Documents).

B. Masonry Joint Reinforcement, General: ASTM A 951.

1. Exterior Walls: Hot-dip galvanized carbon or Stainless steel.
2. Wire Size for Side Rods: W1.7 or 0.148-inchdiameter.
3. Wire Size for Cross Rods: W1.7 or 0.148-inchdiameter.
4. Wire Size for Veneer Ties: W1.7 or 0.148-inchdiameter.
5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 incheso.c.
6. Provide in lengths of not less than 10 feet.
7. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.5 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304.
3. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.
4. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
5. Stainless-Steel Sheet: ASTM A 666, Type 304.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

1. Wire: Fabricate from 1/4-inch- diameter, hot-dip galvanized steel wire.

D. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inchdiameter, hot-dip galvanized steel wire.
2. Tie Section for Steel Frame: Triangular-shaped wire tie, sized to extend within 1 inchof masonry face, made from 0.25-inchdiameter, hot-dip galvanized steel wire.
3. Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.053-inchthick steel.
4. Tie Section for Concrete: Corrugated metal ties with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch of masonry face.

E. Partition Top anchors: 0.105-inch- thick metal plate with 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

F. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:

    a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.

2. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:

    a. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
    b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, having slotted holes for inserting wire tie.
    c. Fabricate sheet metal anchor sections and other sheet metal parts from 0.075-inch-thick, steel sheet, galvanized after fabrication.
    d. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.187-inch- diameter, hot-dip galvanized steel wire.

G. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.6 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with the follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inchintervals along length of flashing to provide an integral mortar bond.

4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counter flashing.
5. Fabricate through-wall flashing with drip edge, unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
6. Fabricate through-wall flashing with sealant stop unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 3/8 inch to form a stop for retaining sealant backer rod.

B. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.

C. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.7 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use one of the following unless otherwise indicated:

1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.

2. Mesh Weep/Vent: Free-draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's standard.

3. Vinyl Weep Hole/Vent: T-shaped units made from flexible PVC, consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Architect.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Provide one of the following configurations:

a. Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings.
b. Strips, not less than 3/4 inch thick and 10 inches wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
c. Sheets or strips full depth of cavity and installed to full height of cavity.
d. Sheets or strips not less than 3/4 inch thick and installed to full height of cavity with additional strips 4 inches high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from being clogged with mortar.

2.8 MASONRY CLEANERS

A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.9 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Limit cementitious materials in mortar to portland cement, mortar cement, and lime.
3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type M.
2. For reinforced masonry, use Type S.

3. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required.

1. Mix to match Government Design professional's selected block sample.

E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Government Design Professional's selected block sample.
2. Application: Use colored aggregate mortar for exposed mortar joints with the following units:

a. Decorative CMUs.
b. Pre-faced CMUs.
c. Concrete facing brick.
d. Face brick.
e. Hollow brick.

F. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

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

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness depicted on design drawings. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

D. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

E. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:

1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/4 inch in 20 feet or 1/2 inch maximum.
2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet or 1/2 inch maximum.
3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/4 inch in 20 feet, or 1/2 inch maximum.
4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch
6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inchhorizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inchhorizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated or shown on Project Structural Design Documents.

3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).

3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.8 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry as follows:

1. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 7 Section "Joint Sealants," but not less than 3/8 inch.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.9 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.

3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products or open head joints to form weep holes.
2. Space weep holes 24 inches o.c. unless otherwise indicated.
3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.

D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

E. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products or open head joints to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.10 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage qualified independent inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.

3.12 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
2. Protect surfaces from contact with cleaner.
3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
4. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.13 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Excess Masonry Waste: Remove excess clean masonry waste and other masonry waste and legally dispose of off Owner's property.

END OF SECTION

SECTION 052100

STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. K-series steel joists.
2. Joist accessories.

1.4 DEFINITIONS

A. SJI's "Specifications": Steel Joist Institute's "Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders."

B. Special Joists: Steel joists or joist girders requiring modification by manufacturer to support non-uniform, unequal, or special loading conditions that invalidate load tables in SJI's "Specifications."

1.5 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.
3. Indicate locations and details of bearing plates to be embedded in other construction.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Welding certificates.

C. Manufacturer certificates.

D. Mill Certificates: For each type of bolt.

E. Comprehensive engineering analysis of special joists signed and sealed by the qualified professional engineer responsible for its preparation.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing joists to comply with performance requirements.

B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

B. Protect joists from corrosion, deformation, and other damage during delivery, storage, and handling.

1.9 SEQUENCING

A. Deliver steel bearing plates to be built into masonry construction.

PART 2 - PRODUCTS

2.1 K-SERIES STEEL JOISTS

A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

1. Joist Type: K-series steel joists.

B. Steel Joist Substitutes: Manufacture according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle or -channel members.

C. Provide holes in chord members for connecting and securing other construction to joists.

D. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."

E. Extended Ends: Extend bearing ends of joists with SJI's Type R extended ends where indicated, complying with SJI's "Specifications."

F. Do not camber joists.

G. Camber joists according to SJI's "Specifications.".

2.2 PRIMERS

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.

2.3 JOIST ACCESSORIES

A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.

B. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.

C. Bridging: Fabricate as indicated and according to SJI's "Specifications." Furnish additional erection bridging if required for stability.

D. Fabricate steel bearing plates from ASTM A 36/A 36M steel with integral anchorages of sizes and thicknesses indicated. Hot-dip zinc coat according to ASTM A 123/A 123M.

E. Steel bearing plates with integral anchorages are specified in Section 055000 "Metal Fabrications."

F. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.

1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

G. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563heavy hex carbon-steel nuts; and ASTM F 436hardened carbon-steel washers.

1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

H. Welding Electrodes: Comply with AWS standards.

I. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.4 CLEANING AND SHOP PAINTING

A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.

B. Do not prime paint joists and accessories to receive sprayed fire-resistive materials.

C. Apply one coat of shop primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 1mil thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates, embedded bearing plates, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION

A. Do not install joists until supporting construction is in place and secured.

B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.

1. Before installation, splice joists delivered to Project site in more than one piece.
2. Space, adjust, and align joists accurately in location before permanently fastening.
3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
4. Delay rigidly connecting bottom-chord extensions to columns or supports until dead loads are applied.

C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

D. Bolt joists to supporting steel framework using carbon-steel bolts.

E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with Research Council on Structural Connection's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.

F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.

B. Visually inspect field welds according to AWS D1.1/D1.1M.

1. In addition to visual inspection, test field welds according to AWS D1.1/D1.1M and the following procedures, as applicable:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709.
c. Ultrasonic Testing: ASTM E 164.
d. Radiographic Testing: ASTM E 94.

C. Visually inspect bolted connections.

D. Correct deficiencies in Work that test and inspection reports have indicated are not in compliance with specified requirements.

E. Perform additional testing to determine compliance of corrected Work with specified requirements.

3.4 PROTECTION

A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists abutting structural steel, and accessories.

1. Clean and prepare surfaces by hand-tool cleaning according to SSPC-SP 2, or power-tool cleaning according to SSPC-SP 3.
2. Apply a compatible primer of same type as primer used on adjacent surfaces.

C. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer that ensures that joists and accessories are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 053100

STEEL DECKING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:

1. Roof deck.

B. Related Sections include the following:

1. Division 03 Section "Cast-in-Place Concrete" for concrete fill.

1.4 SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

C. Product certificates.

D. Welding certificates.

E. Field quality-control test and inspection reports.

F. Research/Evaluation Reports: For steel deck.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

B. Fire-Test-Response Characteristics: Where indicated, provide steel deck units identical to those tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations of applicable testing and inspecting agency.
2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.

C. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

D. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than **25** percent.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

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. CorDeck Building Solutions.
2. Nucor Corp.; Vulcraft Division.
3. United Steel Deck, Inc.
4. “Or Approved Equal.”

2.2 ROOF DECK

A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

1. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: Manufacturer’s standard.

2. Deck Profile: Type NR, narrow rib.
3. Profile Depth: 1-1/2 inches.
4. Gauge: 22
5. Side Laps: Overlapped or interlocking seam at Contractor’s option.

2.3 FORM DECK

1. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade G60 zinc coating.
2. Profile Depth: 1-1/2 inches.
3. Gauge: 22
4. Side Laps: Overlapped or interlocking seam at Contractor's option.

2.4 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 30 for overhang and slab depth.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch (1.90 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.

J. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

3.2 INSTALLATION

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, requirements in this Section, and as indicated.

B. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

C. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

E. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

F. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

G. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

H. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm).

I. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

J. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.4 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on surface of prime-painted deck immediately after installation, and apply repair paint.

C. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 054000

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:

1. Exterior load-bearing wall framing.
2. Interior ceiling support framing.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide cold-formed as detailed herein and capable of withstanding local conditions as dictated by all governing building codes.

B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."

1. Headers: Design according to AISI's "Standard for Cold-Formed Steel Framing - Header Design."
2. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
3. Roof Trusses: Design according to AISI's "Standard for Cold-Formed Steel Framing - Truss Design."

1.5 SUBMITTALS

A. Product Data: For each type of cold-formed metal framing product and accessory indicated.

B. LEED Submittal:

1. Product Data for Credit MR 4.1: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.

    a. Include statement indicating costs for each product having recycled content.

C. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

1. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Welding certificates.

E. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

F. Research/Evaluation Reports: For cold-formed metal framing.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

D. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."

1. Comply with AISI's "Standard for Cold-Formed Steel Framing - Truss Design."
2. Comply with AISI's "Standard for Cold-Formed Steel Framing - Header Design."

E. Comply with AISI's "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide cold-formed metal framing by one of the following:

1. Allied Studco.
2. AllSteel Products, Inc.
3. Dietrich Metal Framing; a Worthington Industries Company.
4. United Metal Products, Inc.
5. Or Approved Equal

2.2 MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.

B. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated.

2.3 LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch.
2. Flange Width: 1-5/8 inches.
3. Gauge: 16 (54mils)
4. Size: 8”
5. Installation Spacing: 16” o.c. maximum.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch minimum
2. Flange Width: 1-1/4 inches minimum.

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch minimum.
2. Flange Width: 1-5/8 inches.

D. Steel Double-L Headers: Manufacturer's standard L-shapes used to form header beams, of web depths indicated, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch minimum.
2. Top Flange Width: 1-5/8 inches minimum.

2.4 CEILING JOISTS

A. Steel Joists: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Size: 6”
2. Minimum Base-Metal Thickness: 0.0451 inch.
3. Flange Width: 1-3/8” inches.
4. Gauge: 18 (43mils)
5. Deflection: L/360
6. Installation Spacing: 12” o.c. maximum.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Size: 6”
2. Minimum Base-Metal Thickness: 0.0451 inch.
3. Flange Width: 1-5/8 inches minimum.
4. Lip: 1/2 inch.
5. Gauge: 18 (43mils)

2.5 HEADERS

A. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Size: 6” minimum.
2. Minimum Base-Metal Thickness: 0.0538 inch minimum.
3. Flange Width: 1-5/8 inches.

B. Steel Double-L Headers: Manufacturer's standard L-shapes used to form header beams, of web depths indicated, and as follows:

1. Size: 6” minimum.
2. Minimum Base-Metal Thickness: 0.0538 inch minimum.
3. Flange Width: 1-5/8 inches.

2.6 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers, knee braces, and girts.
9. Joist hangers and end closures.
10. Hole reinforcing plates.
11. Backer plates.

2.7 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel and carbon-steel nuts; and flat, hardened-steel washers; zinc coated.

C. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.

E. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

F. Welding Electrodes: Comply with AWS standards.

2.8 MISCELLANEOUS MATERIALS

A. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

B. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107, with fluid consistency and 30-minute working time.

C. Shims: Load bearing, high-density multimonomer plastic, nonleaching.

D. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.9 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.

    a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.

4. Fasten other materials to cold-formed metal framing by welding, bolting, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install load bearing shims or grout between the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of foundation wall or slab at stud or joist locations.

3.3 INSTALLATION, GENERAL

A. Cold-formed metal framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.

D. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed metal framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.

H. Install insulation, specified in Division 07 Section "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's standard punched openings.

J. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.4 LOAD-BEARING WALL INSTALLATION

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:

1. Anchor Spacing: To match stud spacing.

B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:

1. Stud Spacing: 16 inches.

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced 48 inches. Fasten at each stud intersection.

1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of 2 screws into each flange of the clip angle for framing members up to 6 inches deep.
2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

J. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 061053

MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. This Section includes the following:

1. Framing with dimension lumber.
2. Wood blocking, cants, and nailers.
3. Plywood.

1.3 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NHLA: National Hardwood Lumber Association.
3. NLGA: National Lumber Grades Authority.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.4 SUBMITTALS

A. Make submissions in accordance with Division 1 Specifications and ‘SCHEDULE OF MATERIAL SUBMITTALS’, attached at the end of the Specifications.

B. No deviations, substitutions or changes of materials, to be incorporated into this project, shall be made after approval by the Department, except for written direction by and the approval of the manufacturer of a specific item and re-approval by the Department.

C. The Department retains the right to require additional items not specifically denoted to be submitted for approval and/or additional clarification.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

B. Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproof, wet work other than painting is dry, and HVAC system is operating and maintaining temperature and humidity at occupancy levels.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA C2.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

D. Application: Treat all miscellaneous carpentry, unless otherwise indicated.

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

3. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 DIMENSION LUMBER FRAMING

A. Maximum Moisture Content: 15 percent for 2-inch nominal thickness or less, 19 percent for more than 2-inch nominal thickness.

B. Other Framing: Construction or No. 2 grade and the following species:

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Shims.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content of any species.

C. For exposed boards, provide lumber with 19 percent maximum moisture content.

D. For concealed boards, provide lumber with 19 percent maximum moisture content.

E. For blocking not used for attachment of other construction Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

G. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Lag Bolts: ASME B18.2.1.

G. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.6 METAL FRAMING ANCHORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cleveland Steel Specialty Co.
2. Simpson Strong-Tie Co., Inc.
3. Or Approved Equal.

B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.

1. Use for interior locations unless otherwise indicated.

D. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.

1. Use for wood-preservative-treated lumber and where indicated.

E. Joist Hangers: U-shaped joist hangers with 2-inch- long seat and 1-1/4-inch- wide nailing flanges at least 85 percent of joist depth.

1. Thickness: 0.062 inch.

F. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch above base and with 2-inch- minimum side cover, socket 0.062 inch thick, and standoff and adjustment plates 0.108 inch thick.

G. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, 1-1/2 inches wide by 0.050 inch thick. Tie fastens to side of rafter or truss, face of top plates, and side of stud below.

H. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, 1-1/4 inches wide by 0.050 inch thick by 36 inches (914 mm) long.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.

D. Do not splice structural members between supports, unless otherwise indicated.

E. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

F. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

G. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

H. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
3. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's Uniform Building Code.
4. Table 2305.2, "Fastening Schedule," in BOCA's BOCA National Building Code.
5. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
6. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
7. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One- and Two-Family Dwelling Code.

I. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.3 PLYWOOD INSTALLATION

A. Install where indicated on drawings and where required for attaching other work.

B. Plywood shall be secured into framing.

3.4 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 061600

SHEATHING

PART 1 - GENERAL

1.1 STIPULATIONS

A. A.The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Ceiling sheathing.

1.4 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
3. For building wrap, include data on air-/moisture-infiltration protection based on testing according to referenced standards.

1.5 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack plywood and other panels flat with spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory." and GA-600, "Fire Resistance Design Manual.".

2.2 WOOD PANEL PRODUCTS

A. Emissions: Products shall meet the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Certified Wood: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

1. Plywood.
2. Oriented strand board.
3. Particleboard underlayment.
4. Hardboard underlayment.

C. Plywood: Either DOC PS 1 or DOC PS 2 unless otherwise indicated.

D. Oriented Strand Board: DOC PS 2.

2.3 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction, Use Category UC3b for exterior construction.

B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.4 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
2. Design Value Adjustment Factors: Treated lumber plywood shall be tested according ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat all plywood unless otherwise indicated.

2.5 WALL SHEATHING

A. Plywood Wall Sheathing: Exterior sheathing.

1. Span Rating: Not less than 32/16.
2. Nominal Thickness: Not less than ½ inch.

B. Oriented-Strand-Board Wall Sheathing: Exposure 1 sheathing.

1. Span Rating: Not less than 48/24.
2. Nominal Thickness: As depicted on Drawings, not less than ½ inch.

2.6 ROOF SHEATHING

A. Plywood Roof Sheathing: Exterior sheathing.

1. Span Rating: Not less than 48/24.
2. Nominal Thickness: Not less than ½ inch.

2.7 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Power-Driven Fasteners: NES NER-272.

C. Wood Screws: ASME B18.6.1.

D. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

1. For wall and roof sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

2.8 WEATHER-RESISTANT SHEATHING PAPER

A. Building Wrap: ASTM E 1677, Type I air retarder; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E 84; UV stabilized; and acceptable to authorities having jurisdiction.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Dow Chemical Company (The); Styrofoam Weathermate Plus Brand Housewrap.
b. DuPont (E. I. du Pont de Nemours and Company); Tyvek .
c. Raven Industries Inc.; Rufco-Wrap.

2. Water-Vapor Permeance: Not less than 125 g through 1 sq. m of surface in 24 hours per ASTM E 96, Desiccant Method (Procedure A).
3. Allowable UV Exposure Time: Not less than three months.

B. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

2.9 MISCELLANEOUS MATERIALS

A. Adhesives for Field Gluing Panels to Framing: Formulation complying with ASTM D 3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

1. Adhesives shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
b. MFM Building Products Corp.; Window Wrap.
c. Polyguard Products, Inc.; Polyguard 300.

C. Primer for Flexible Flashing: Product recommended by manufacturer of flexible flashing for substrate.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."
3. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's "International Residential Code for One- and Two-Family Dwellings."

D. Coordinate wall sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

E. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

F. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.

B. Fastening Methods: Fasten panels as indicated below:

1. Wall and Roof Sheathing:

a. Screw to cold-formed metal framing.
b. Space panels 1/8 inch apart at edges and ends.

3.3 WEATHER-RESISTANT SHEATHING-PAPER INSTALLATION

A. General: Cover sheathing with weather-resistant sheathing paper as follows:

1. Cut back barrier 1/2 inch on each side of the break in supporting members at expansion- or control-joint locations.
2. Apply barrier to cover vertical flashing with a minimum 4-inch overlap, unless otherwise indicated.

B. Building Wrap: Comply with manufacturer's written instructions.

1. Seal seams, edges, fasteners, and penetrations with tape.
2. Extend into jambs of openings and seal corners with tape.

3.4 FLEXIBLE FLASHING INSTALLATION

A. Apply flexible flashing where indicated to comply with manufacturers written instructions.

1. Prime substrates as recommended by flashing manufacturer.
2. Lap seams and junctures with other materials at least 4 inches, except that at flashing flanges of other construction, laps need not exceed flange width.
3. Lap flashing over weather-resistant building paper at bottom and sides of openings.
4. Lap weather-resistant building paper over flashing at heads of openings.
5. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

END OF SECTION

SECTION 072101

SPRAY POLYURETHANE FOAM INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Spray-applied cellulosic insulation.
2. Spray polyurethane foam insulation.
3. Vapor retarders.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.

3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 SPRAY POLYURETHANE FOAM INSULATION

A. Closed-Cell Polyurethane Foam Insulation: ASTM C 1029, Type II, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. BASF Corporation.
   b. BaySystems NorthAmerica, LLC.
   c. Dow Chemical Company (The).
   d. "Or Approved Equal"

2. Minimum density of 1.5 lb/cu. ft., thermal resistivity of 6.2 deg F x h x sq. ft./Btu x in. at 75 deg F.

B. Open-Cell Polyurethane Foam Insulation: Spray-applied polyurethane foam using water as a blowing agent, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. BaySystems NorthAmerica, LLC.
   b. Demilec (USA) LLC.
   c. Gaco Western Inc.
   d. "Or Approved Equal"

2. Minimum density of 0.4 lb/cu. ft., thermal resistivity of 3.4 deg F x h x sq. ft./Btu x in. at 75 deg F.

2.2 VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils (min) thick, with maximum permeance rating of 0.13 perm.

B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

D. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Spray-Applied Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:

1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.4 INSTALLATION OF VAPOR RETARDERS

A. Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with

adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs.

1. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches o.c.
2. Before installing vapor retarders, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
3. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.

C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.5 PROTECTION

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 074217

INSULATED METAL PANELS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Insulated metal wall and ceiling panels and associated accessories.

1.4 SUBMITTALS

A. Product Data: Manufacturer’s data sheets on each product to be used including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Material type, metal thickness and finish.
4. Installation methods.

B. Shop Drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, including specific requirements indicated.

1. Profile and gauge of both exterior and interior sheet.
2. Metal finish.
3. Details and connections to and locations of supporting steel indicating control points.

C. Samples:
1. For each type of exposed finish required.
2. One color chart representing manufacturer’s full range of available colors.

D. Quality Control Submittals:

1. Statement of qualifications.
2. Design data.
3. Test reports.

E. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Company specializing in manufacturing of all required aspects of insulated metal panel production.

1. No less than 10 years of experience in the actual production of specified products.
2. Third party certification of Quality Control program and materials utilized, in compliance with rigid factory guidelines, which includes quarterly unannounced inspections by independent testing laboratories, capable of providing reports directly to code authority.
3. Successfully completed not less than 100 comparable scale projects using this system.
4. Company specializing in manufacturing factory continuous lamination of insulated metal panels with a minimum documented experience of 10 years.
5. Company specializing in on site manufacturing rigid foam insulation for the purpose of insulated metal panels with a minimum documents experience of 10 years.

B. Installer Qualifications: Experienced in installation of system similar in complexity for specific requirements.

1. Installer shall be responsible for installation of panel and support framing as specified in this section to comply with the following:
   a. Wind load engineering to comply with code requirements.
2. Acceptable to or licensed by insulated metal panel manufacturer.
3. Not less than 3 years' experience with systems.
4. Successfully completed not less than 5 comparable scale projects using this system.

C. Product Requirements:

1. Metal members (prone to rust) and wood or wood by-products (prone to moisture absorption and rot), shall not be permitted within the panel connection system.
2. Insulated panels, related accessories, and construction details shall be in accordance with the following regulatory agency, where required:
   a. United States Department of Agriculture (USDA).
3. Wall and ceiling panels, insulated with polyisocyanurate.
4. Panel manufacturer shall have third party inspections of panel manufacturing process on a quarterly basis.

1.6 PERFORMANCE REQUIREMENTS

A. Thermal Performance:

1. Panels shall produce no post manufacturing off gassing which could result in loss of further thermal resistance and must have a certified Long Term R-Value (LTR).

B. Fire:

1. Surface Burning Characteristics: Insulated core shall have been tested in accordance with ASTM E 84 and UL 723, NFPA 255 for surface burning characteristics. The core shall have a maximum flame spread of 0 and a smoke developed rating of 175.
2. Exterior Burning Characteristics: Exterior panel skin shall have been tested in accordance with ASTM E 84 and UL723, NFPA 255 for surface burning characteristics. The exterior shall have a maximum flame spread of 0 and a smoke developed rating of 185.

C. Vapor Barrier:

1. Water Spray Leakage test shall show no evidence of penetration through the panels or panel joints when subjected to a preload air pressure of 30 psi and a water spray rate of 5 gallons/psf/per hour for 15 minutes, per Factory Mutual Research Corporation FM 4471 test procedures for class 1 roof panels.
2. Static Water Penetration must exhibit no sign of leakage for a period of 7 days with ponded water at a 6 inch continuous water depth for the duration of the test, per Factory Mutual Research corporation FM4471 test procedures for class 1 roof panels.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products per manufacturer’s recommendations until ready for installation.

B. Store products off the ground, with panels sloped for drainage and covered to protect factory finishes from damage.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.8 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.

1.9 WARRANTY

A. Limited Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.

1. Warranty Period: **One year** from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Provide coil coater’s written warranty on paint finish for adhesion to the substrate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. PermaTherm, Inc.
   b. "Or Approved Equal"

2.2 INSULATED METAL PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. PermaTherm, Perma-Core CS
   a. PWP Series: Perma-Core: Insulated metal wall panels
   b. IRP Series: Perma-Core: Insulated metal ceiling panels
2. "Or Approved Equal."

B. Insulated Metal Panels: Roll-formed exterior and interior steel sheet faces laminated to panel polyisocyanurate foam core. Polyisocyanurate core shall not contain CFC's, HCFC's or HFC's. Insulated wall and ceiling panels shall be supplied in widths of 45.5 inches (+/- 1/8"). Panel lengths shall be factory cut to meet required site dimensions.

1. Interior Face: Clad on all exposed areas with 26 gauge pre-painted G90 galvanized steel
2. Metal: 26-gauge min. galvanized (facer and liner)
3. Surface: Embossed or Smooth
4. Profile: Shadow Lines
5. Width: 45.5 inches
6. Thickness: 6 inches
7. Core Material: Polyisocyanurate Insulation
   a. Density: 2.5#
8. R-Value: R-8 Per Inch of Thickness
9. Finish: Siliconized Polyester (USDA approved)
10. Color: White

C. Lamination and Joint Fabrication:

1. Metal skins shall be thermal-set to the polyisocyanurate insulation. Insulated panels shall be manufactured individually laminated, ensuring uniform adhesion between metal skins and polyisocyanurate insulation.
2. Panel edges shall be fabricated with tongue-in groove type panel connection system (Z-lock).
3. Slip joints shall be sealed internally by running continuous beads of FSI-96 butyl caulking (or approved alternate) along the warm inside edge of the female side of the panel joints.
4. Slip joints shall be externally caulked for USDA inspected areas only, or as specified, with white silicone (or approved alternate).

D. Flashing and Trim: Brake-formed sheet metal in the same thickness and finish to match the panels.

E. Fasteners: Clips, anchoring devices, and accessories for installation of panel system as recommended by panel manufacturer for the system specified.

F. Sealant: As recommended by panel manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Panel installer to verify that structural steel supports for wall panels are within tolerances in the AISC Code of Standard Practice, Section 7 and supplement modification controlling Section 7.11.3, adjustable items. Limit maximum deviation of steel alignment to plus or minus 3/16 inch (4mm) from the control with a 1/8 inch (3mm) maximum change in deviation for any member for any 10 feet length of panel.

2. Do not proceed until unsatisfactory conditions have been corrected.

B. If support system preparation is the responsibility of another installer, notify government design professional of unsatisfactory preparation before proceeding.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions and industry standards.

B. Fasteners according to manufacturer's recommendations and verified as suitable by project installer.

C. Field fabrication of corner panel connections shall be butted or mitered, flashed, and finished by installation crew on-site.

D. Form panel shape as indicated on Drawings, accurate in size, square, and free from distortion or defects.

E. Install flashing and trim true and in proper alignment.

F. Install sealants where indicated to clean dry surfaces only without skips or voids, to ensure weather tightness and integrity of the vapor barrier.

3.3 FIELD QUALITY CONTROL

A. The installer shall make periodic inspections and issue a report to Government Design Professional or Project Manager regarding compliance with manufacturer's installation recommendations developed for the project.

3.4 ADJUSTING AND CLEANING

A. Repair damage caused during construction.

1. Touch-up mars, scratches and cut edges to match original finish.
2. If repairs cannot be made to comply with Government Design Professional's requirements, remove damaged materials and install new.

B. Replace damaged panels and other component sof work, which cannot be repaired by finish touch-up or similar minor repair.

C. Wipe finished surfaces clean of any filings caused by drilling or cutting to prevent rust staining.

D. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.

END OF SECTION

SECTION 079200

JOINT SEALANTS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes joint sealants for the following applications:

1. Exterior joints in the following vertical surfaces and horizontal non-traffic surfaces:

    a. Construction joints in cast-in-place concrete.
    b. Control and expansion joints in unit masonry.
    c. Joints between metal panels.
    d. Joints between different materials listed above.
    e. Perimeter joints between materials listed above and frames of doors and windows.
    f. Other joints as indicated.

2. Exterior joints in the following horizontal traffic surfaces:

    a. Isolation and contraction joints in cast-in-place concrete slabs.
    b. Tile control and expansion joints.
    c. Other joints as indicated.

3. Interior joints in the following vertical surfaces and horizontal non-traffic surfaces:

    a. Control and expansion joints on exposed interior surfaces of exterior walls.
    b. Perimeter joints of exterior openings where indicated.
    c. Tile control and expansion joints.
    d. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    e. Other joints as indicated.

4. Interior joints in the following horizontal traffic surfaces:

    a. Isolation joints in cast-in-place concrete slabs.

b. Control and expansion joints in tile flooring.
c. Other joints as indicated.

B. Related Sections include the following:

1. Division 4 Section "Unit Masonry Assemblies" for masonry control and expansion joint fillers and gaskets.
2. Division 8 Section "Glazing" for glazing sealants.

1.4 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.5 SUBMITTALS

A. Product Data: For each joint-sealant product indicated.

B. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.7 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer's standard form in which elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five (5) years from date of Substantial Completion.

C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
2. Disintegration of joint substrates from natural causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

C. Colors of Exposed Joint Sealants: As indicated by manufacturer's designations.

2.2 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

D. Multicomponent Pourable Neutral-Curing Silicone Sealant:

1. Type and Grade: M (multicomponent) and P (pourable).
2. Class: 25.
3. Uses Related to Exposure: T (traffic) and NT (non-traffic).
4. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

    a. Use O Joint Substrates: Galvanized steel.

E. Single-Component Pourable Neutral-Curing Silicone Sealant:

1. Type and Grade: S (single component) and P (pourable).
2. Class: 100/50.
3. Uses Related to Exposure: NT and T (traffic).
4. Uses Related to Joint Substrates: M A and O, as applicable to joint substrates indicated.

    a. Use O Joint Substrates: Galvanized steel.

F. Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant:

1. Type and Grade: S (single component) and NS (non-sag).
2. Class: 25.
3. Use Related to Exposure: NT (non-traffic).
4. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

    a. Use O Joint Substrates: Coated glass, color anodic aluminum, aluminum coated with a high-performance coating, galvanized steel and ceramic tile.

G. Multicomponent Pourable Urethane Sealant:

1. Type and Grade: M (multicomponent) and P (pourable).
2. Class: 25.
3. Use Related to Exposure: T (traffic).
4. Uses Related to Joint Substrates: M, A, and, as applicable to joint substrates indicated, O.

    a. Use O Joint Substrates: Ceramic tile.

H. Multicomponent Pourable Urethane Sealant:

1. Type and Grade: M (multicomponent) and P (pourable).
2. Class: 25.

3. Uses Related to Exposure: T (traffic) and NT (non-traffic).
4. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates indicated, O.

    a. Use O Joint Substrates: Color anodic aluminum and aluminum coated with a high-performance coating.

2.3 SOLVENT-RELEASE JOINT SEALANTS

A. Butyl-Rubber-Based Solvent-Release Joint Sealant: Comply with ASTM C 1085.

B. Pigmented Narrow-Joint Sealant: Manufacturer's standard, solvent-release-curing, pigmented, synthetic-rubber sealant complying with AAMA 803.3 and formulated for sealing joints 3/16 inch or smaller in width.

2.4 PREFORMED JOINT SEALANTS

A. Preformed Silicone-Sealant System: Manufacturer's standard system consisting of precured low-modulus silicone extrusion, in sizes to fit joint widths indicated, combined with a neutral-curing silicone sealant for bonding extrusions to substrates.

B. Preformed Foam Sealant: Manufacturer's standard preformed, pre-compressed, open-cell foam sealant that is manufactured from high-density urethane foam impregnated with a nondrying, water-repellent agent; is factory produced in pre-compressed sizes in roll or stick form to fit joint widths indicated; is coated on one side with a pressure-sensitive adhesive and covered with protective wrapping; develops a watertight and airtight seal when compressed to the degree specified by manufacturer; and complies with the following:

1. Properties: Permanently elastic, mildew resistant, non-migratory, non-staining, and compatible with joint substrates and other joint sealants.

    a. Density: Manufacturer's standard.

2.5 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Elastomeric Tubing Sealant Backings: Neoprene, butyl, EPDM, or silicone tubing complying with ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26 deg F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth, and to otherwise contribute to optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.6 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.

b. Glass.
c. Porcelain enamel.
d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Installation of Preformed Silicone-Sealant System: Comply with the following requirements:

1. Apply masking tape to each side of joint, outside of area to be covered by sealant system.
2. Apply silicone sealant to each side of joint to produce a bead of size complying with preformed silicone-sealant system manufacturer's written instructions and covering a bonding area of not less than 3/8 inch. Hold edge of sealant bead 1/4 inch inside masking tape.

3. Within 10 minutes of sealant application, press silicone extrusion into sealant to wet extrusion and substrate. Use a roller to apply consistent pressure and ensure uniform contact between sealant and both extrusion and substrate.
4. Complete installation of sealant system in horizontal joints before installing in vertical joints. Lap vertical joints over horizontal joints. At ends of joints, cut silicone extrusion with a razor knife.

G. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping, taking care not to pull or stretch material, producing seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures where expansion of sealant requires acceleration to produce seal, apply heat to sealant in compliance with sealant manufacturer's written instructions.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION

SECTION 081113

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:

1. Standard hollow-metal steel doors.
2. Standard hollow-metal steel frames.

B. Related Sections include the following:

1. Division 4 Section "Unit Masonry Assemblies" for building anchors into and grouting standard steel frames in masonry construction.
2. Division 8 Sections for door hardware for standard steel doors.
3. Division 8 Sections for Blast Resistant Ratings
4. Division 9 Painting Sections for field painting standard steel doors and frames.

1.4 DEPARTMENT OF DEFENSE REQUIREMENT

A. All exterior doors and windows, to include, but not limited to frames, glazing, anchoring, etc. **must** comply with the following regulation(s):

1. Unified Facilities Criteria (UFC) 4-010-01and (UFC) 4-020-01: DoD Minimum Antiterrorism Standards for Buildings

1.5 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

1.6 SUBMITTALS

A. Product Data: Include construction details, material descriptions, core descriptions, label compliance, fire-resistance rating and finishes for each type of steel door and frame specified.

B. Shop Drawings: In addition to requirements below, provide a schedule of standard steel doors and frames using same reference numbers for details and openings as those on Drawings:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details.
3. Frame details for each frame type, including dimensioned profiles.
4. Details and locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, accessories, joints, and connections.
7. Details of conduit and preparations for electrified door hardware and controls.

C. Qualification Data: For Installer.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.

C. Source Limitations: Obtain standard steel doors and frames through one source from a single manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch- high wood blocking. Avoid using non-vented plastic or canvas shelters that could create a humidity chamber.

1. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.9 PROJECT CONDITIONS

A. Field Measurements: Verify openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating standard steel

frames without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.10 COORDINATION

A. Coordinate installation of anchorages for standard steel frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in masonry. Deliver such items to Project site in time for installation.

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. Ceco Door Products; an ASSA ABLOY Group Company.
2. Fleming Door Products Ltd.; an ASSA ABLOY Group Company.
3. Kewanee Corporation (The).
4. Steelcraft; an Ingersoll-Rand Company.
5. "Or Approved Equal"

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 zinc-iron-alloy (galvannealed) coating designation.

D. Electrolytic Zinc-Coated Steel Sheet: ASTM A 591/A 591M, Commercial Steel (CS), Class B coating; mill phosphatized.

E. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls according to ASTM A 153/A 153M, Class B.

F. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized according to ASTM A 153/A 153M.

G. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching standard steel door frames of type indicated.

H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-developed indexes of 25 and 50 respectively; passing ASTM E 136 for combustion characteristics.

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type non-corrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD STEEL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces, unless otherwise indicated. Comply with ANSI A250.8.

1. Design: Flush panel.
2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polyurethane, or vertical steel-stiffener core that produces doors complying with ANSI A250.8.

    a. Fire Door Core: As required to provide fire-protection ratings indicated.
    b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 6.0 deg F x h x sq. ft. /Btu when tested according to ASTM C 1363.

        1) Locations: Exterior doors.

3. Vertical Edges for Single-Acting Doors: Beveled edge.

    a. Beveled Edge: 1/8 inch in 2 inches.

4. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.
5. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick end closures or channels of same material as face sheets.
6. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Hardware Reinforcement: Fabricate reinforcement plates from same material as door face sheets to comply with the following minimum sizes:

1. Hinges: Minimum 0.123 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
2. Pivots: Minimum 0.167 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
3. Lock Face, Flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch thick.
4. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.

C. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD STEEL FRAMES

A. General: Comply with ANSI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated from metallic-coated steel sheet.

1. Fabricate frames with mitered or coped and welded face corners and seamless face joints.
2. Frames for Level 2 Steel Doors: 0.053-inch- thick steel sheet, unless otherwise indicated.

C. Interior Frames: Fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior frame requirements.

1. Fabricate frames with mitered or coped and welded face corners and seamless face joints, unless otherwise indicated.
2. Fabricate knocked-down frames with mitered or coped corners, for field assembly.
3. Fabricate knocked-down, drywall slip-on frames for in-place gypsum board partitions.
4. Frames for Wood Doors: 0.053-inch- thick steel sheet.

D. Hardware Reinforcement: Fabricate reinforcement plates from same material as frames to comply with the following minimum sizes:

1. Hinges: Minimum 0.123 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
2. Pivots: Minimum 0.167 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
3. Lock Face, Flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch thick.
4. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.

E. Supports and Anchors: Fabricated from electrolytic zinc-coated or metallic-coated steel sheet.

F. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
3. Compression Type for Slip-on Frames: Adjustable compression anchors.

G. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:

1. Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

H. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.5 STOPS AND MOLDINGS

A. Fixed Frame Moldings: Formed integral with standard steel frames, minimum 5/8 inch high, unless otherwise indicated.

B. Astragals: Provide Astragals and/or Astragal Weather Strips at all exterior double doors.

2.6 FABRICATION

A. General: Fabricate standard steel doors and frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Standard Steel Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

C. Standard Steel Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners, unless otherwise indicated.
3. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
4. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Two anchors per jamb up to 60 inches in height.
2) Three anchors per jamb from 60 to 90 inches in height.
3) Four anchors per jamb from 90 to 120 inches in height.
4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof more than 120 inches in height.

b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches in height.
2) Four anchors per jamb from 60 to 90 inches in height.
3) Five anchors per jamb from 90 to 96 inches in height.
4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof more than 96 inches in height.
5) Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.

c. Compression Type: Not less than two anchors in each jamb.

5. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Provide plastic plugs to keep holes clear during construction.

    a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

D. Hardware Preparation: Factory prepare standard steel doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware."

1. Reinforce doors and frames to receive non-templated mortised and surface-mounted door hardware.
2. Comply with applicable requirements in ANSI A250.6 and ANSI/DHI A115 Series specifications for door and frame preparation for hardware. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.

E. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
2. Provide loose stops and moldings on inside of hollow metal work.
3. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.
4. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
5. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
6. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

2.7 STEEL FINISHES

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish standard steel door and frames after assembly.

2.8 Color and Gloss: As selected by Government Design Professional from manufacturer's full range.

A. Metallic-Coated Steel Surface Preparation: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

B. Steel Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel; comply with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

C. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

2.9 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch wide steel.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of standard steel doors and frames.

1. Examine roughing-in for embedded and built-in anchors to verify actual locations of standard steel frame connections before frame installation.
2. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory.

B. Prior to installation and with installation spreaders in place, adjust and securely brace standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive non-templated mortised and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Provide doors and frames of sizes, thicknesses, and designs indicated. Install standard steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Standard Steel Frames: Install standard steel frames for doors and other openings, of size and profile indicated. Comply with SDI 105.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-protection-rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
    c. Install door silencers in frames before grouting.
    d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    e. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    f. Apply bituminous coating to backs of frames that are filled with mortar, grout, and plaster containing antifreeze agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with post installed expansion anchors.

    a. Floor anchors may be set with powder-actuated fasteners instead of post installed expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar as specified in Division 4 Section "Unit Masonry Assemblies."
5. In-Place Gypsum Board Partitions: Secure frames in place with post installed expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
6. Installation Tolerances: Adjust standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:

a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Standard Steel Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:

a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including standard steel doors or frames that are warped, bowed, or otherwise unacceptable.

B. Clean grout and other bonding material off standard steel doors and frames immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

D. Galvannealed Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION

SECTION 083613

SECTIONAL DOORS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract,” “Special Conditions,” and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section includes insulated sectional doors.

B. Related Section:

1. Division 05 Section "Metal Fabrications" for miscellaneous steel supports.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Sectional doors shall meet performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.

B. Structural Performance: Exterior sectional doors shall withstand the effects of gravity loads, and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Wind Loads: Uniform pressure (velocity pressure) of 20 lbf/sq. ft., acting inward and outward.

C. Air Infiltration: Maximum rate not more than indicated when tested according to ASTM E 283 or DASMA 105.

1. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. at 15 and 25 mph.

1.4 SUBMITTALS

A. Product Data: For each type and size of sectional door and accessory.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each exposed product and for each color and texture specified.

D. Maintenance data.

E. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard for Sectional Doors: Fabricate sectional doors to comply with DASMA 102 unless otherwise indicated.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 STEEL DOOR SECTIONS

A. Exterior Section Faces and Frames: Fabricate from manufacturer's standard zinc-coated (galvanized), cold-rolled, steel sheet.

1. Roll horizontal meeting edges to a continuous, interlocking, keyed, rabbeted, shiplap, or tongue-in-groove weathertight seal, with a reinforcing flange return.
2. For insulated doors, provide sections with continuous thermal-break construction, separating the exterior and interior faces of door.

B. Section Ends and Intermediate Stiles: Enclose open ends of sections with channel end stiles formed from galvanized-steel sheet welded to door section. Provide intermediate stiles formed from galvanized-steel sheet, cut to door section profile, and welded in place. Space stiles not more than 48 inches apart.

C. Reinforce bottom section with a continuous channel or angle conforming to bottom-section profile and allowing installation of astragal.

D. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Provide galvanized-steel bars, struts, trusses, or strip steel, formed to depth and bolted or welded in place. Ensure that reinforcement does not obstruct vision lites.

E. Provide reinforcement for hardware attachment.

F. Thermal Insulation: Insulate interior of steel sections with door manufacturer's standard CFC-free insulation, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within steel sections that incorporate the following interior facing material, with no exposed insulation:

1. Interior Facing Material: Zinc-coated (galvanized), cold-rolled, commercial steel (CS) sheet.

2.2 TRACKS, SUPPORTS, AND ACCESSORIES

A. Tracks: Manufacturer's standard, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances shown on Drawings. Provide complete track assembly including brackets, bracing, and reinforcement for rigid support of ball-bearing roller guides for required door type and size. Slot vertical sections of track spaced 2 inches (51 mm) apart for door-drop safety device. Slope tracks at proper angle from vertical or design tracks to ensure tight closure at jambs when door unit is closed.

B. Track Reinforcement and Supports: Galvanized-steel track reinforcement and support members. Secure, reinforce, and support tracks as required for door size and weight to provide strength and rigidity without sag, sway, and vibration during opening and closing of doors.

C. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.

D. Windows: Manufacturer's standard window units of type and size indicated and in arrangement shown. Provide removable stops of same material as door-section frames.

2.3 HARDWARE

A. General: Provide heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.

B. Hinges: Heavy-duty, galvanized-steel hinges at each end stile and at each intermediate stile, according to manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails.

C. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Provide 3-inch- diameter roller tires for 3-inch- wide track and 2-inch- roller tires for 2-inch- wide track.

D. Push/Pull Handles: For push-up or emergency-operated doors, provide galvanized-steel lifting handles on each side of door.

2.4 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.

B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

1. Lock Cylinders: Provide cylinders standard with manufacturer and keyed to building keying system.
2. Keys: Two for each cylinder.

C. Chain Lock Keeper: Suitable for padlock.

D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.5 COUNTERBALANCE MECHANISM

A. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.

B. Cable Drums and Shaft for Doors: Cast-aluminum or gray-iron casting cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft.

C. Cables: Galvanized-steel lifting cables.

D. Cable Safety Device: Include, on each side-edge of door, a device designed to automatically stop door if either lifting cable breaks.

E. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.

F. Provide a spring bumper at each horizontal track to cushion door at end of opening operation.

2.6 DOOR ASSEMBLY (Drawings A.1.1 and A.2.1)

A. Steel Sectional Door: Sectional door formed with hinged sections.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. General American Door Company.
   b. Martin Door Manufacturing.

c. Overhead Door Corporation.
d. "Or Approved Equal."

B. Operation Cycles: Not less than 10,000.

C. R-Value: 18.4.

D. Steel Sections: Zinc-coated (galvanized) steel sheet, formed into sections 2 inches thick.

1. Exterior-Face Surface: Flat or ribbed.
2. Interior Facing Material: Zinc-coated (galvanized) steel sheet.

E. Track Configuration: Vertical-lift track.

F. Weatherseals: Fitted to bottom and top and around entire perimeter of door. Provide combination bottom weatherseal and sensor edge.

G. Windows: Approximately 24 by 7 inches with curved corners, in one row; installed with insulated glazing of clear float glass.

H. Locking Devices: Equip door with locking device assembly.

1. Locking Device Assembly: Single-jamb side, locking bars, operable from inside with thumbturn.

I. Door Finish:
1. Baked-Enamel or Powder-Coated Finish: Color and gloss as selected by Government Design Professional from manufacturer's full range.
2. Factory Prime Finish: Manufacturer's standard color.
3. Finish of Interior Facing Material: Finish as selected by Government Design Profesional from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install sectional doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Tracks: Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment. Repair galvanized coating on tracks according to ASTM A 780.

C. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion. Adjust doors and seals to provide weathertight fit around entire perimeter.

3.2 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain sectional doors.

END OF SECTION

SECTION 083614

COLD STORAGE SLIDING DOORS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract,” “Special Conditions,” and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. Section includes insulated sliding doors.

B. Related Section:

1. Division 05 Section "Metal Fabrications" for miscellaneous steel supports.
2. Division 26 Sections for electrical service and connections for powered operators and accessories.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Cold storage doors shall meet performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.

1.4 SUBMITTALS

A. Product Data: For each type and size of sectional door and accessory.

B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each exposed product and for each color and texture specified.

D. Maintenance data.

E. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Standard for Sectional Doors: Fabricate sectional doors to comply with DASMA 102 unless otherwise indicated.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of sectional doors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 COLD STORAGE SLIDING DOORS (Drawings A.1.1 and A.2.1)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Thermostop, Inc.
2. “Or Approved Equal.”

B. Materials:
1. Pre-painted galvanized G-60 metal sheet (ASTM A653).
2. Commercial aluminum extrusions (6063 T5).
3. Insulation: foamed in place polyurethane (CGSB 51-GP-21M).

C. Temperature range:
1. Cooler: 4º C & above / 38º F & above
2. Freezer: -30º C to 2º C / -22º F to 36ºF

D. Size: As indicated on Drawing A.2.1.

E. Thickness and R- values:
1. 4” (R-32) thick.

F. Insulation: CFC- free rigid foamed in place polyurethane. 2.56lbs/ft^3 minimum density.

G. Finish: 26 ga. steel w/ white stucco finish.

H. Face frame and back frame: Standard 1" thick extruded aluminum face frame, mill finish, to self support the door and hardware load.
   1. Optional: back frame made with same material as face frame.

I. Heat trace: Provide at all freezer locations and as indicated on Drawing A.2.1

J. Kickplate: 24" high steel, 1/16" aluminum checker plate.

K. Seals: airtight compression seals at door frame and double bottom sweep seals, as recommended by door manufacturer.

L. Hardware: Heavy-duty double track and trolley assembly roller systems.
   1. Zinc-coated, galvanized steel.

M. Motor:
   1. A/C one-speed motor.
   2. Safety pneumatic edge.
   3. 12" per second on opening and closing
   4. Bi-parting door: High speed operation up to 48" per second at opening.
   5. 15" cycles maximum per hour.
   6. Options for 115V, 230V or 460V (coordinated with electrical specifications).
   7. Size: 10"W x 13" H x 11" D
   8. Corrosion-resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install sliding doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Tracks: Provide sway bracing, diagonal bracing, and reinforcement as required for rigid installation of track and door-operating equipment. Repair galvanized coating on tracks according to ASTM A 780.

C. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion. Adjust doors and seals to provide weathertight fit.

END OF SECTION

SECTION 087111

DOOR HARDWARE

PART 1 - GENERAL

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:

1. Commercial door hardware for the following:

a. Swinging doors.
b. Other doors to the extent indicated.

2. Cylinders for doors specified in other Sections.

B. Related Sections include the following:

1. Division 8 Section "Steel Doors and Frames" for astragals provided as part of a fire-rated labeled assembly and for door silencers provided as part of the frame.
2. Division 8 Section "Aluminum Entrances and Storefronts" for entrance door hardware, except cylinders.

1.4 SUBMITTALS

A. Product Data: Include installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of door hardware indicated.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

1. Include lists of completed projects with project names and addresses of architects and owners, and other information specified.

D. Maintenance Data: For each type of door hardware to include in maintenance manuals specified in Division 1.

E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Supplier Qualifications: Door hardware supplier with warehousing facilities in Project's vicinity and who is or employs a qualified Architectural Hardware Consultant, available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.

1. Scheduling Responsibility: Preparation of door hardware and keying schedules.

C. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.

D. Regulatory Requirements: Comply with provisions of the following:

1. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," as follows:

a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
b. Door Closers: Comply with the following maximum opening-force requirements indicated:

1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

c. Thresholds: Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.

2. NFPA 101: Comply with the following for means of egress doors:

a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
b. Door Closers: Not more than 30 lbf to set door in motion and not more than 15 lbf to open door to minimum required width.
c. Thresholds: Not more than 1/2 inch high.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Keys to be handed over to the Government Representative at final Construction Progress Meeting.

1.7 WARRANTY

A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of operators and door hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

C. Warranty Period: Three (3) years from date of Substantial Completion, unless otherwise indicated.

D. Warranty Period for Manual Closers: Ten (10) years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in this Section**,** the Door Hardware Schedule located on sheet A.2.1.

1. Door Hardware Sets: Requirements for quantity, item, design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Schedule at the end of Part 3. Products are identified by descriptive titles corresponding to requirements specified in Part 2.

2.2 HINGES AND PIVOTS, GENERAL

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. Hinges:

a. Stanley Commercial Hardware; Div. of The Stanley Works.

2. Continuous Geared Hinges:

a. McKinney Products Company; Div. of ESSEX Industries, Inc.

B. Standards: Comply with the following:

1. Butts and Hinges: BHMA A156.1.
2. Template Hinge Dimensions: BHMA A156.7.

C. Quantity: Provide the following, unless otherwise indicated:

1. Two Hinges: For doors with heights up to 60 inches.
2. Three Hinges: For doors with heights 61 to 90 inches.
3. Four Hinges: For doors with heights 91 to 120 inches.
4. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

D. Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

Maximum Door Size (inches)	Hinge Height (inches)	Metal Thickness (inches)	
		Standard Weight	Heavy Weight
34 by 84 by 1-3/8	3-1/2	0.123	-
36 by 84 by 1-3/8	4	0.130	-
36 by 84 by 1-3/4	4-1/2	0.134	0.180

E. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

F. Hinge Applications: Unless otherwise indicated, provide the following:

1. Entrance Doors: Heavy-weight hinges.
2. Doors with Closers: Antifriction-bearing hinges.
3. Interior Doors: Standard-weight hinges.

G. Hinge Base Metal: Unless otherwise indicated, provide the following:

1. Exterior Hinges: Stainless steel, with stainless-steel pin.
2. Interior Hinges: Stainless steel, with stainless-steel pin.
3. Hinges for Fire-Rated Assemblies: Stainless steel, with stainless-steel pin.

H. Hinge Options: Comply with the following:

1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:

   a. Outswinging exterior doors.
   b. Outswinging corridor doors with locks.

2. Corners: Square.
3. Reverse Safety Stud: Metal stud extension on back of each leaf that engages hole in reinforcing plate.
4. Safety Stud: Metal stud extension on exposed side of one leaf that engages hole in opposite leaf when door is closed.

I. Fasteners: Comply with the following:

1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
2. Screws: Phillips flat-head screws; machine screws (drilled and tapped holes) for metal doors. Finish screw heads to match surface of hinges.

2.3 HINGES

A. Antifriction-Bearing, Full-Mortise (Butt) Hinges: Standard weight; BHMA Grade 2, with 2 ball bearings; button tips; non-rising removable pins; and base metal as follows:

1. Base Metal: Stainless steel.

B. Plain-Bearing, Standard-Weight, Full-Mortise (Butt) Hinges: BHMA Grade 3, button tips, non-rising removable pins, and base metal as follows:

1. Base Metal: Stainless steel.

2.4 LOCKS AND LATCHES, GENERAL

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. Mechanical Locks and Latches:

   a. Best Access Systems: Div. of Stanley Security Solutions, Inc. – **DMVA STANDARD, NO SUBSTITUTIONS ALLOWED**.

B. Standards: Comply with the following:

1. Bored Locks and Latches: BHMA A156.2.
2. Mortise Locks and Latches: BHMA A156.13.
3. Interconnected Locks and Latches: BHMA A156.12.
4. Auxiliary Locks: BHMA A156.5.
5. Push-Button Combination Locks: BHMA A156.2.

C. Bored Locks: BHMA Grade 2; Series 4000.

D. Mortise Locks: Stamped steel case with steel or brass parts; BHMA Grade 2; Series 1000.

E. Interconnected Locks: BHMA Grade 1, unless Grade 2 is indicated; Series 5000.

F. Auxiliary Locks: BHMA Grade 1, unless Grade 2 is indicated.

G. Certified Products: Provide door hardware listed in the following BHMA directories:

1. Mechanical Locks and Latches: BHMA's "Directory of Certified Locks & Latches."

H. Lock Trim: Comply with the following:

1. Lever: Wrought, forged, or cast.
2. Knob: Wrought, forged, or cast.
3. Escutcheon (Rose): Wrought, forged, or cast.
4. Dummy Trim: Match lever lock trim and escutcheons.
5. Lockset Designs: Provide lockset design designated below or, if sets are provided by another manufacturer, provide designs that match those designated:

a. Bored Locks: Best Access Systems – Post Standard, no substitutions allowed

I. Lock Functions: Function numbers and descriptions indicated in the Door Hardware Schedule comply with the following:

1. Bored Locks: BHMA A156.2.
2. Mortise Locks: BHMA A156.13.
3. Interconnected Locks: BHMA A156.12.

J. Lock Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Bored Locks: Minimum 1/2-inch latchbolt throw.
2. Mortise Locks: Minimum 3/4-inch latchbolt throw.
3. Deadbolts: Minimum 1-inch bolt throw.

K. Rabbeted Doors: Provide special rabbeted front and strike on locksets for rabbeted meeting stiles.

L. Backset: 2-3/4 inches, unless otherwise indicated.

2.5 MECHANICAL LOCKS AND LATCHES

A. Bored Auxiliary Locks: Comply with the following:

1. Material: Stainless steel.
2. Deadlocks: Deadbolt operated by key either side.

2.6 HIGH SECURITY LOCKS AND LATCHES

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. High Security Locks and Latches:

   a. KABA MAS Security and Control: **CDX-10**
   b. "Or Approved Equal"

B. Operation: Lock opens by entering a digital numeric code via twist dial. Comply with the following:

1. Power: Internal, self-powered.
2. Combinations: 3 modes:

   Single: 1 million combinations
   Dual: 500 billion combinations
   Supervisor/Subordinate: 2 million combinations

3. Direct Dial: No need to clear before entering combination. Once you stop turning the dial, the power will shut down after 40 seconds.
4. Dead Zones: None
5. Memory: Non-volatile
6. LCD: Limited View Liquid Crystal Display with indicator arrows.
7. Combination Changes: (LCD indicator in change key mode). Combination changed with correct combination or serial number.
8. Random Number View: True Scramble
9. Daylocking: No
10. Back Dialing: No
11. Lock Reset: Automatic when bolt is thrown or 40 seconds after turning has stopped.
12. Manipulation: Fail secure against high-voltage attack, robot attack, X-ray methods, magnetic, vibration, and R/F.
13. Wrong Try Penalty: 10-14 errors results in a 3 minute time out. 15 errors or greater results in a 4 minute time out. Both error count and penalty time resets with valid combination.
14. Back Cover: Lock On Back Cover pin prevents removing the back cover without the combination.
15. Exit/Panic Hardware: Lock shall be interconnected with exit device releasing deadbolt and latch bolt when touch bar is depressed.

2.7 DOOR BOLTS, GENERAL

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. Flush Bolts: Best Access Systems – Post Standard, no substitutions allowed

B. Standards: Comply with the following:

1. Automatic and Self-Latching Flush Bolts: BHMA A156.3.
2. Manual Flush Bolts: BHMA A156.16.

C. Flush Bolts: BHMA Grade 2, designed for mortising into door edge.

D. Bolt Throw: Comply with testing requirements for length of bolts to comply with labeled fire door requirements, and as follows:

1. Mortise Flush Bolts: Minimum 3/4-inch throw.

2.8 DOOR BOLTS

A. Automatic Flush Bolts: Fabricated from steel and brass components, with spring-activated bolts that automatically retract when active leaf is opened and that automatically engage when active door depresses bolt trigger. Provide brass or stainless-steel cover plate, top and bottom strikes, guides, guide supports, wear plates, and shims.

B. Self-Latching Flush Bolts: Fabricated from steel and brass components, with spring-activated bolts that automatically engage when active door depresses trigger. Bolts are manually retracted by a slide in the bolt face. Provide brass or stainless-steel cover plate, top and bottom strikes, guides, guide supports, wear plates, and shims.

2.9 EXIT DEVICES, GENERAL

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. Corbin Russwin Architectural Hardware; Div. of Yale Security Inc.

B. Standard: BHMA A156.3.

1. BHMA Grade: Grade 1, unless Grade 2 is indicated.

C. Certified Products: Provide exit devices listed in BHMA's "Directory of Certified Exit Devices."

D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

E. Surface Vertical-Rod Exit Devices: Grade 1.

1. Type: Type 2
2. Grade: Grade 1.
3. Actuating Bar: Cross bar
4. Material: Stainless steel
5. Configuration: Top and bottom rods.
6. Electrified Options (where designated):

a. Pushpad monitor switch.
b. Double-pushpad monitor switch.
c. Electric locking and unlocking.
d. Delayed egress.
e. Alarm.

F. Outside Trim: Knob with cylinder; material and finish to match locksets, unless otherwise indicated.

1. Match design for locksets and latch sets, unless otherwise indicated.

G. Through Bolts: For exit devices and trim on metal doors.

2.10 EXIT DEVICES

A. Mortise Exit Devices: Comply with the following:

1. Type: Type 3.
2. Actuating Bar: Push pad.
3. Material: Stainless steel.

2.11 CYLINDERS AND KEYING

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:

a. Cylinders: Best Access Systems: Div. of Stanley Security Solutions, Inc. – **DMVA STANDARD, NO SUBSTITUTIONS ALLOWED**.

B. Standards: Comply with the following:

1. Cylinders: BHMA A156.5.

C. Cylinder Grade: BHMA Grade 2.

D. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:

1. Number of Pins: Six.
2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
4. Bored-Lock Type: Cylinders with tailpieces to suit locks.

a. High-Security Grade: BHMA Grade 1A, listed and labeled as complying with pick- and drill-resistant testing requirements of UL 437 (Suffix A).

E. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:

1. Interchangeable Cores: Core insert, removable by use of a special key, and usable with other manufacturers' cylinders.
2. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.

F. Construction Cores & Keying: Comply with the following:

1. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
2. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 5 construction master keys.
    a. At the conclusion of the project, construction cores shall be turned over to Stanley/Best Lock representative. Stanley/Best Lock shall furnish permanent cores to the Government Project Manager or other designated representative. Government Project Manager will furnish the permanent cores DMVA Keying Shop for keying based on facility user Keying Schedule.

G. Keying System: Keying of permanent cores will be completed by DMVA Keying Shop. Contractor shall coordinate keying needs with Government Project Manager and Facility User.

H. Keys: Unless otherwise noted, provide nickel-silver keys complying with the following:

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

    a. Notation: Information to be furnished by Government.

2. Quantity: In addition to one extra blank key for each lock, provide the following:

    a. Cylinder Change Keys: Three.
    b. Master Keys: Five.

2.12 STRIKES

A. Standards: Comply with the following:

1. Strikes for Bored Locks and Latches: BHMA A156.2.
2. Strikes for Mortise Locks and Latches: BHMA A156.13.
3. Strikes for Interconnected Locks and Latches: BHMA A156.12.
4. Strikes for Auxiliary Deadlocks: BHMA A156.5.

B. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

2.13 OPERATING TRIM, GENERAL

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. Stanley Commercial Hardware; Div. of The Stanley Works.

B. Flat Push Plates: 0.050 inch (min) thick, 4 inches wide by 16 inches high with square corners and beveled edges; secured with exposed screws.

C. Straight Door Pulls: With minimum clearance of 1-1/2 inches from face of door.

1. Type: 3/4-inch constant-diameter pull.
2. Mounting: Surface applied with concealed fasteners or Through bolted with oval-head machine screws and countersunk washers.
3. Overall Length: 9 inches.

D. Standard: Comply with BHMA A156.6.

E. Materials: Fabricate from stainless steel, unless otherwise indicated.

2.14 OPERATING TRIM

A. Flat Push Plates: 0.050 inch thick, 4 inches wide by 16 inches high; with square corners and beveled edges, secured with exposed screws.

B. Single Push Bar: Horizontal bar, with minimum clearance of 1-1/2 inches from face of door, and as follows:

1. Shape and Size: Minimum 3/8-by-1-1/4-inch flat bar.
2. Mounting: Surface applied with concealed fasteners.

2.15 ACCESSORIES FOR PAIRS OF DOORS

A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release.

B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.

C. Flat Overlapping Astragals: BHMA A156.22; flat stainless steel metal bar, surface mounted on face of door with screws; minimum 1/8 inch thick by 2 inches wide by full height of door.

D. CLOSERS, GENERAL

E. 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. Surface-Mounted Closers:

F. Standards: Comply with the following:

1. Closers: BHMA A156.4.

G. Surface Closers: BHMA Grade 2.

H. Certified Products: Provide door closers listed in BHMA's "Directory of Certified Door Closers."

I. Power-Assist Closers: As specified in Division 8 Section "Power Door Operators" for access doors for the disabled or where listed in the Door Hardware Schedule. Provide electrohydraulic, electromechanical, and pneumatic types as indicated.

J. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.16 CLOSERS

A. Modern-Type-with-Cover Surface Closers: Rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; with forged-steel main arm; enclosed in cover indicated; complying with the following:

1. Mounting: Hinge side.
2. Type: Delayed action closing.
3. Backcheck: Adjustable, effective between 60 and 85 degrees of door opening.
4. Cover Material: Aluminum.
5. Closing Power Adjustment: At least 35 percent more than minimum tested value.

2.17 PROTECTIVE TRIM UNITS, GENERAL

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. Metal Protective Trim Units:

a. Baldwin Hardware Corporation.

B. Standard: Comply with BHMA A156.6.

C. Materials: Fabricate protection plates from the following:

1. Stainless Steel: 0.050 inch thick; beveled top and 2 sides.

D. Fasteners: Provide manufacturer's standard exposed fasteners for door trim units consisting of either machine or self-tapping screws.

E. Furnish protection plates sized 1-1/2 inches less than door width on push side and 1/2 inch less than door width on pull side, by height specified in schedule.

2.18 PROTECTIVE TRIM UNITS

A. Kick Plates: 12 inches high by door width, with allowance for frame stops.

2.19 STOPS AND HOLDERS

A. Stops and Bumpers: BHMA A156.16**,** Grade 1 unless Grade 2 is indicated.

1. Provide floor stops for doors unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders.

B. Combination Floor and Wall Stops and Holders: BHMA A156.8, Grade 1 unless Grade 2 is indicated.

C. Wall Bumpers: Polished cast brass or aluminum with rubber bumper; 2-1/2-inch diameter, minimum 3/4-inch projection from wall, with back plate for concealed fastener installation; with concave bumper configuration.

2.20 DOOR GASKETING, GENERAL

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. Door Gasketing:

a. Reese Enterprises, Inc.

B. Standard: Comply with BHMA A156.22.

C. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide non-orrosive fasteners for exterior applications and elsewhere as indicated.

1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

D. Air Leakage: Not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Gasketing Materials: Comply with ASTM D 2000 and AAMA 701/702.

2.21 DOOR GASKETING

A. Adhesive-Backed Perimeter Gasketing: Gasket material applied to frame rabbet with self-adhesive.

1. Gasket Material: Sponge neoprene.

B. Exterior Door Sweeps: Nylon brush gasket material held in place by flat aluminum housing or flange; surface mounted to face of door with screws.

2.22 THRESHOLDS, GENERAL

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. Reese Enterprises, Inc.
2. National Guard Products
3. Pemko Manufacturing Co.; an ASSA ABLOY Group Company

B. Standard: Comply with BHMA A156.21.

2.23 THRESHOLDS

A. Saddle Thresholds:

1. Type: Fluted top or Carpet separator with fluted top (at carpet locations).
2. Base Metal: Aluminum.

B. Plate Thresholds: Solid metal plate; and base metal as follows:

1. Top Surface: Fluted with slip-resistant abrasive.
2. Base Metal: Stainless steel.

C. Ramped Thresholds: Modular, interlocking, sloped, fluted-top metal assemblies with closed return ends; 1:12 slope.

1. Top Surface: Fluted with slip-resistant abrasive.
2. Base Metal: Aluminum.

D. Latching/Rabbeted Panic Thresholds:

1. Type: Fluted, barrier free top.
2. Base Metal: Aluminum.

2.24 MISCELLANEOUS DOOR HARDWARE, GENERAL

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. Standard: Comply with the following:

1. Auxiliary Hardware: BHMA A156.16.

C. Auxiliary Hardware: BHMA Grade 2, unless otherwise indicated.

2.25 MISCELLANEOUS DOOR HARDWARE

2.26 FABRICATION

A. Manufacturer's Nameplate: Do not provide manufacturers' products that have manufacturer's name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise approved by Architect.

1. Manufacturer's identification will be permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18 for finishes. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Steel Machine or Wood Screws: For the following fire-rated applications:

    a. Mortise hinges to doors.
    b. Strike plates to frames.
    c. Closers to doors and frames.

3. Steel Through Bolts: For the following fire-rated applications, unless door blocking is provided:

    a. Closers to doors and frames.

4. Spacers or Sex Bolts: For through bolting of hollow metal doors.
5. Fasteners for Wood Doors: Comply with requirements of DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.27 FINISHES

A. Standard: Comply with BHMA A156.18.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. BHMA Designations: Comply with base material and finish requirements indicated by the following:

1. BHMA 600: Primed for painting, over steel base metal.
2. BHMA 605: Bright brass, clear coated, over brass base metal.
3. BHMA 606: Satin brass, clear coated, over brass base metal.
4. BHMA 609: Satin brass, blackened, satin relieved, clear coated, over brass base metal.
5. BHMA 611: Bright bronze, clear coated, over bronze base metal.
6. BHMA 612: Satin bronze, clear coated, over bronze base metal.
7. BHMA 613: Dark-oxidized satin bronze, oil rubbed, over bronze base metal.
8. BHMA 618: Bright nickel plated, clear coated, over brass or bronze base metal.
9. BHMA 619: Satin nickel plated, clear coated, over brass or bronze base metal.
10. BHMA 622: Flat black coated, over brass or bronze base metal.
11. BHMA 623: Light-oxidized statuary bronze, clear coated, over bronze base metal.
12. BHMA 624: Dark-oxidized statuary bronze, clear coated, over bronze base metal.
13. BHMA 625: Bright chromium plated over nickel, over brass or bronze base metal.
14. BHMA 626: Satin chromium plated over nickel, over brass or bronze base metal.
15. BHMA 627: Satin aluminum, clear coated, over aluminum base metal.
16. BHMA 628: Satin aluminum, clear anodized, over aluminum base metal.
17. BHMA 629: Bright stainless steel, over stainless-steel base metal.
18. BHMA 630: Satin stainless steel, over stainless-steel base metal.
19. BHMA 651: Bright chromium plated over nickel, over steel base metal.
20. BHMA 652: Satin chromium plated over nickel, over steel base metal.
21. BHMA 689: Aluminum painted, over any base metal.
22. BHMA 690: Dark bronze painted, over any base metal.
23. BHMA 691: Light bronze painted, over any base metal.
24. BHMA 717: Bright aluminum, uncoated; aluminum base metal.
25. BHMA 718: Satin aluminum, uncoated; aluminum base metal.
26. BHMA 722: Dark-oxidized bronze, oil rubbed, over architectural bronze base metal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance of door hardware.

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

3.2 PREPARATION

A. Wood Doors: Comply with DHI A115-W series.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

1. Door Closers: Adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.

B. Six-Month Adjustment: Approximately six months after date of Substantial Completion, Installer shall perform the following:

1. Examine and readjust each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.
2. Consult with and instruct Owner's personnel on recommended maintenance procedures.
3. Replace door hardware items that have deteriorated or failed due to faulty design, materials, or installation of door hardware units.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

END OF SECTION

SECTION 089516

EXPLOSION RELIEF VENTS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:
   1. Explosion Relief Vents.

B. Related Sections include the following:
   1. Steel Framing.
   2. Flashing and Sheet Metal.
   3. Joint Sealants.

1.4 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated.

B. Shop Drawings: Explosion vents/framing system for approval prior to fabrication. Include product location, fabrication details, attachments to other work, specific static release loads and static release forces. plans, elevations, sections, details, and attachments to other work.
   1. Installation instructions shall be submitted along with shop drawings.

C. Samples: For units with factory-applied color finishes.

D. Qualification Data: For Installer.

E. Maintenance Data: For explosion vent systems.

F. Warranties: Explosion vent warranties as provided by manufacturer and as outlined in the Warranty section of this specification.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.

1. Engineering Responsibility: Preparation of data for steel-framed systems including Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.

B. The panel system shall be produced by a manufacturer regularly engaged in manufacture of similar products and with a verifiable history of successful product applications.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect panel finish and edges in accordance with manufacturer’s recommendations.

B. Store materials in accordance with panel manufacturer’s recommendations.

1.8 WARRANTY

A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Noise or vibration caused by thermal movements.
c. Deterioration of metalsand other materials beyond normal weathering.
d. Water leakage through fixed glazing and framing areas.

2. Warranty Period: Five years from date of Substantial Completion.

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes fail within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: 20 years from date of Substantial Completion.

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. Explovent® pressure relief panel systems shall be manufactured by Construction Specialties, Inc., Cranford, NJ; or C/S Construction Specialties Company, Mississauga, Ontario.
2. BS&B Safety Systems, LLC.
3. "Or Approved Equal."

2.2 EXPLOSION RELIEF VENTS

A. DESCRIPTION:
1. Pressure relief panel system shall be designed and shop calibrated to release at a static pressure differential between interior and exterior of 20 PSF +/- 10% (As recommended per NFPA 68 and IFC and Section 911.2.5).
2. The panels and structure supports shall be designed to withstand a maximum wind load of 30 PSF.
3. Each panel shall be shop calibrated and tested for proper operation and for release at the design loads specified on the approved shop drawings.
4. All panels shall be permanently marked with the design release pressure and the maximum static release force.
5. Each panel shall be equipped with a restraint/hold open mechanism designed to cushion the panel's deceleration as the full open position is reached.
6. Panel testing: Dynamic test data shall demonstrate that the panel release, restraint, and hold open mechanisms performed properly, the panels were not structurally damaged, and the panels could be reset. In addition, the test data shall include all pertinent operating conditions under which the test was conducted including static release pressure and the additional pressure rise within the chamber.
    a. System design shall allow for non-destructive testing in the field to verify that the panels release at the specified static design pressure.

B. MATERIAL:
1. Panels shall be semi-rigid insulated core with .032" (.81mm) thick 3003 or 5005 stucco (or optional smooth finish) aluminum allot sheet laminated to both sides. Total depth of panel shall be 2" (50.8mm).
2. Panel framing components shall be .063" (1.6mm) 6063-T52 alloy extruded aluminum. All fasteners shall be aluminum or stainless steel.
3. Exterior panel gaskets shall be a pile fiber type with a continuous polypropylene center fin. Interior gaskets shall consist of open cell compression foam and clad with a polyethylene liner.
4. Finish: 100% Fluropolymer Resin Powder Coat. To meet or exceed AAMA 2605-5 criteria.
5. Color: As selected by Government Design Professional from manufacturers full range or colors.

2.3 FABRICATION

A. Fabricate the pressure relief panels to the sizes shown on the approved shop drawings.

B. Panels shall be top hinged as detailed as shown on the approved shop drawings.

C. All panels, frames, and release mechanisms shall be factory assembled in units and shipped to the job site.

D. Head, sill, jamb, and mullion frame members to be one piece extruded aluminum structural members as detailed, and to have integral caulking slots. Mullions to be two-piece interlocking assemblies, which allow for expansion and contraction, and for individual panel removeability.

E. All panels shall have exterior pile gaskets and interior compression (or magnet) gaskets to minimize air leakage and water entrainment when closed.

F. The release mechanism shall be mounted to the panel frame, and shall be shop calibrated and tested for the design loads specified on approved drawings.

PART 3 - EXECUTION

3.1 EXPLOSION VENT INSTALLATION

A. The vents must be installed in accordance with shop drawings, the installation instructions, and any special instruction on the shop drawing per Manufacturer’s recommendations.

3.2 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete explosion panel assembly including trim, caps, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.3 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed unless otherwise indicated in manufacturer’s written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.

B. After panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Ensure panels and trim are clean and free of debris prior to applying sealant.

END OF SECTION

SECTION 092216

NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications "General Conditions of the Construction Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes non-load-bearing steel framing members for the following applications:

1. Interior framing systems.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

PART 2 - PRODUCTS

2.1 NON-STRUCTURAL METAL FRAMING, GENERAL

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
2. Protective Coating: manufacturer's standard corrosion-resistant zinc coating, unless otherwise indicated.

2.2 STEEL FRAMING FOR FRAMED ASSEMBLIES

A. Steel Studs and Runners: ASTM C 645.
1. Minimum Base-Metal Thickness: 0.0179 inch.

B. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: 0.0179 inch.

D. Cold-Rolled Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base Metal Thickness: 0.0179 inch.
2. Depth: As indicated on Drawings.

F. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.

1. Configuration: Asymmetrical or hat shaped.

G. Cold-Rolled Furring Channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.
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.

H. 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.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

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.

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

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work 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 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

B. Install studs so flanges within framing system point in same direction.

C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb, unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

    a. Fire-stop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.

D. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

E. Z-Furring Members:

1. Erect insulation (specified in Division 7 Section "Building Insulation") vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION

SECTION 099113

EXTERIOR PAINTING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following exterior substrates:

1. Concrete.
2. Concrete masonry units (CMU).
3. Steel.
4. Galvanized metal.
5. Aluminum (not anodized or otherwise coated).
6. Wood.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For each finish and for each color and texture required.

C. Product List: Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.5 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."

2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Government Design Professional will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.

a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on benchmark samples.

a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Sherwin-Williams Company (The)
2. Benjamin Moor & Co.
3. PPG Paints
4. “Or Approved Equal”

B. Source Limitations: Obtain each paint product from single source from single manufacturer.

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Colors: As selected by Government Design Professional from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Plaster: 12 percent.
5. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION AND APPLICATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

D. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.3 EXTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

1. Latex System: MPI EXT 3.1A.

a. Prime Coat: Exterior latex matching topcoat.
b. Intermediate Coat: Exterior latex matching topcoat.
c. Topcoat: Exterior latex semigloss.

B. CMU Substrates:

1. Latex System: MPI EXT 4.2A.

a. Prime Coat: Interior/exterior latex block filler.
b. Intermediate Coat: Exterior latex matching topcoat.
c. Topcoat: Exterior latex semigloss.

2. Latex Over Alkali-Resistant Primer System: MPI EXT 4.2L.

a. Prime Coat: Alkali-resistant primer.
b. Intermediate Coat: Exterior latex matching topcoat.
c. Topcoat: Exterior latex semigloss.

C. Steel Substrates:

1. Alkyd System: MPI EXT 5.1D.

    a. Prime Coat: Alkyd anticorrosive metal primer.
    b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    c. Topcoat: Exterior alkyd enamel semigloss.

D. Aluminum Substrates:

1. Latex System: MPI EXT 5.4H.

    a. Prime Coat: Quick-drying primer for aluminum.
    b. Intermediate Coat: Exterior latex matching topcoat.
    c. Topcoat: Exterior latex gloss.

2. Alkyd System: MPI EXT 5.4F.

    a. Prime Coat: Quick-drying primer for aluminum.
    b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    c. Topcoat: Exterior alkyd enamel gloss.

E. Wood Panel Substrates: Including fascias.

1. Latex System: MPI EXT 6.4K.

    a. Prime Coat: Exterior latex wood primer.
    b. Intermediate Coat: Exterior latex matching topcoat.
    c. Topcoat: Exterior latex semigloss.

END OF SECTION

SECTION 099123

INTERIOR PAINTING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications “General Conditions of the Construction Contract”, “Special Conditions” and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Gypsum board.

B. Related Sections include the following:

1. Division 9 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection and Verification: For each type of topcoat product indicated.

1. Prior to the start of painting, contractor shall prepare (1) 24”x24” mock-up for each color selected by Government Design Professional. Contractor shall utilize the same application methods detailed herein for each mock-up and allow a 24 hour drying period prior to the observation by the Government Inspector and/or Design Professional. Contractor may only begin interior top coats upon receiving approval of the mock-ups from the appointed Government Inspector.

C. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.

2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.5 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.

1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. of each material and color applied.

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. M.A.B. Paints.
2. Sherwin-Williams Company (The).

3. "Or Approved Equal"

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. Chemical Components of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:

1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
2. Non-flat Paints and Coatings: VOC content of not more than 150 g/L.
3. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
4. Restricted Components: Paints and coatings shall not contain any of the following:

a. Acrolein.
b. Acrylonitrile.
c. Antimony.
d. Benzene.
e. Butyl benzyl phthalate.
f. Cadmium.
g. Di (2-ethylhexyl) phthalate.
h. Di-n-butyl phthalate.
i. Di-n-octyl phthalate.
j. 1,2-dichlorobenzene.
k. Diethyl phthalate.
l. Dimethyl phthalate.
m. Ethylbenzene.
n. Formaldehyde.
o. Hexavalent chromium.
p. Isophorone.
q. Lead.
r. Mercury.
s. Methyl ethyl ketone.
t. Methyl isobutyl ketone.
u. Methylene chloride.
v. Naphthalene.
w. Toluene (methylbenzene).
x. 1,1,1-trichloroethane.
y. Vinyl chloride.

C. Colors: As selected by Government Design Professional from manufacturer's full range.

2.3 PRIMERS/SEALERS (1 Coat)

A. Interior Latex Primer/Sealer: MPI #50.

1. VOC Content: 200 per liter maximum

2.4 METAL PRIMERS

A. Rust-Inhibitive Primer (Water Based): MPI #107.

1. VOC Content: 200 per liter maximum

2.5 TEX PAINTS (2 Coats)

A. Interior Latex (Flat): MPI #53 (Gloss Level 1).

1. VOC Content: 100 per liter

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Concrete Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

G. Aluminum Substrates: Remove surface oxidation.

H. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

I. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:

1. Owner will engage the services of a qualified testing agency to sample paint materials being used. Samples of material delivered to Project site will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove non-complying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by t, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. Gypsum Board Substrates:

1. Latex System: MPI INT 9.2A.

a. Prime Coat: Interior latex primer/sealer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (flat).

END OF SECTION

SECTION 111300

LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Dock seals.
2. Transparent-strip door curtains.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for loading dock equipment. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For loading dock equipment. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For each type of dock seal and shelter fabric indicated.

D. Samples for Verification: For each type of dock seal and shelter fabric indicated.

E. Qualification Data: For qualified Installer.

F. Operation and Maintenance Data: For loading dock equipment to include in operation and maintenance manuals.

G. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

B. Source Limitations: Obtain loading dock equipment from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store and handle dock seals and shelters in a manner to avoid significant or permanent damage to fabric or frame.

1. Comply with manufacturer's written instructions for minimum and maximum temperature requirements for storage.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of construction contiguous with loading dock equipment, by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM 36/A 36M.

B. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from steel plate complying with ASTM A 572/A 572M, Grade 55 (380).

C. Steel Tubing: ASTM A 500, cold formed.

D. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

E. Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried.

F. Pressure-Treated Wood: DOC PS 20 dimension lumber, select structural grade, kiln dried, and pressure treated with waterborne preservatives to comply with AWPA C2.

2.2 FOAM-PAD DOCK SEALS

A. General: Dock seals consisting of fabric-covered foam pads designed to compress 4 to 5 inches under pressure of truck body to form an airtight seal at jambs and head of loading dock openings; of type, size, and construction indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Blue Giant Equipment Corporation.
b. Nova Technology.
c. McGuire.
d. “Or Approved Equal.”

B. Door Opening Size: 9’-0” x 9’-0” (field verify)

C. Stationary Head Pad: 18 inches or 24 inches (match existing) high and same depth as jamb pads; sized for opening width.

D. Jamb Pads: Square.

1. Nominal Size: 12 inches wide and sized for opening height.

E. Construction: Consisting of single- or double-ply, coated, fabric-covered, urethane-foam core with supporting frame. Fabricate jamb and head pads of same depth and sized for opening width.

1. Pressure-Treated Wood Support Frame: Factory painted; with steel mounting hardware.
2. Steel Support Frame: Steel channel frame of manufacturer's standard weight, shape, and finish; with steel mounting hardware.
3. Tapered Side Panels: Taper side panels to angle required to accommodate sloped loading dock approach grades and make sealing edge of dock shelter parallel to back edge of truck. Taper for declined approach (field verify).
4. Cover Fabric: Vinyl-coated nylon or polyester with minimum total weight of 22 oz./sq. yd.

a. Color: As selected by Government Design Professional from manufacturer's full range.

5. Cover Fabric: Manufacturer's proprietary cover fabric complying with the following minimum requirements:

a. Tearing strength of not less than 300 by 300 lbf when tested according to ASTM D 2261.
b. Abrasion resistance of not less than 6000 cycles when tested according to FED-STD-191A-5306.
c. Tensile strength of not less than 1200 by 1200 lbf when tested according to FED-STD-191A-5100.1.
d. Cold resistance to minus 40 deg F when tested according to FED-STD-191A-5874.
e. Color: As selected by Government Design Professional from manufacturer's full range.

6. Guide Strips: 4-inch- wide, coated, nylon guide strips on jamb pads.
7. Pleated Protectors: On face of jamb pads of overlapping layers of coated fabric attached to base fabric; 8-inch wear exposure.

2.3 TRANSPARENT-STRIP DOOR CURTAINS

A. General: Door curtains consisting of overlapping strips suspended from top of opening to form a sealed door curtain. Provide strips of length required to suit opening height and with sufficient number in unit to close opening width with overlap indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Floor Products Company, Inc.
   b. Chase Doors.
   c. Flexon, Inc.
   d. "Or Approved Equal."

B. Strip Material: Curved, clear, transparent, extruded PVC. Fabricate strips for manufacturer's standard method of attachment to overhead mounting system indicated.

1. Low-Temperature Grade: USDA accepted, designed to withstand temperature range of minus 30 to plus 150 deg F (minus 34 to plus 66 deg C).
2. Strip Width and Thickness: 8 inches (203 mm) wide and 0.080 inch (2 mm) thick.
3. Overlap: One-third.

C. Header Mounting: Consisting of an angle bolted or welded to opening lintel; equip angle with permanently attached mounting pins and a steel-angle or -plate retaining strip attached to angle with wing nuts.

D. Wall Surface Mounting: Consisting of a steel plate bolted to side of lintel; equip plate with permanently attached, threaded, mounting pins and steel-angle or -plate retaining strip attached to plate with wing nuts.

E. Wall Surface Mounting: Consisting of steel pipe attached to side of lintel by manufacturer's standard, winged-U-type suspension brackets.

F. Wall Surface Mounting: Consisting of a rigid, vinyl wall-mounting unit bolted to side of lintel above opening; equip unit with a similarly formed, rigid, vinyl retainer attached to unit with wing nuts.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of loading dock equipment.

B. Examine roughing-in for electrical systems for loading dock equipment to verify actual locations of connections before equipment installation.

C. Examine walls and floors of pits for suitable conditions where recessed loading dock equipment is to be installed. Pits shall be plumb and square and properly sloped for drainage from back to front of loading dock.

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

3.2 PREPARATION

A. Coordinate size and location of loading dock equipment indicated to be attached to or recessed into concrete or masonry, and furnish anchoring devices with templates, diagrams, and instructions for their installation.

3.3 INSTALLATION

A. Dock Seals: Attach dock-seal support frames securely to building structure in proper relation to openings, dock bumpers, and dock levelers to ensure compression of dock seals when trucks are positioned against dock bumpers.

B. Transparent-Strip Door Curtains: Attach door-curtain mounting system to lintel with screw anchors or toggle bolts. Mount curtain strips to achieve overlap indicated.

3.4 ADJUSTING

A. Adjust loading dock equipment to function smoothly and safely, and lubricate as recommended by manufacturer.

B. After completing installation of exposed, factory-finished loading dock equipment, inspect exposed finishes and repair damaged finishes.

END OF SECTION

SECTION 220533

HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes plumbing piping heat tracing for freeze prevention, domestic hot-water-temperature maintenance, and snow and ice melting on roofs and in gutters and downspouts with the following electric heating cables:

1. Plastic insulated, series resistance.
2. Self-regulating, parallel resistance.
3. Constant wattage.

B. Related Requirements:

1. Section 210533 "Heat Tracing for Fire-Suppression Piping."
2. Section 230533 "Heat Tracing for HVAC Piping."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

1. BriskHeat.
2. Chromalox.
3. Delta-Therm Corporation.
4. Easy Heat; a division of EGS Electrical Group LLC.
5. Nelson Heat Trace; a division of EGS Electrical Group LLC.
6. Pyrotenax; a brand of Tyco Thermal Controls LLC.
7. Raychem; a brand of Tyco Thermal Controls LLC.
8. Thermon Americas Inc.
9. Trasor Corp.

C. Comply with IEEE 515.1.

D. Heating Element: Pair of parallel [No. 16] [No. 18] AWG, [tinned] [nickel-coated], stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

E. Electrical Insulating Jacket: Flame-retardant polyolefin.

F. Cable Cover: Stainless-steel braid and polyolefin outer jacket with ultraviolet inhibitor.

G. Maximum Operating Temperature (Power On): 150 deg F.

H. Maximum Exposure Temperature (Power Off): [185 deg F.

I. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

J. Capacities and Characteristics:

1. Maximum Heat Output: 12 W/ft..
2. Piping Diameter: NPS
3. Number of Parallel Cables:
4. Spiral Wrap Pitch: inches
5. Electrical Characteristics for Single-Circuit Connection:

a. Volts: 208 or 480.
b. Phase:
c. Hertz:
d. Full-Load Amperes:
e. Minimum Circuit Ampacity:
f. Maximum Overcurrent Protection:

2.2 CONTROLS

A. Pipe-Mounted Thermostats for Freeze Protection:

1. Remote bulb unit with adjustable temperature range from 30 to 50 deg F
2. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
3. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.
4. Corrosion-resistant, waterproof control enclosure.

B. Programmable Timer for Domestic Hot-Water-Temperature Maintenance:

1. Microprocessor based.
2. Minimum of four separate schedules.
3. Minimum 24-hour battery carryover.
4. On-off-auto switch.
5. 365-day calendar with 20 programmable holidays.
6. Relays with contacts to indicate operational status, on or off, and for interface with central HVAC control-system workstation.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Section 220553 "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

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

3.2 APPLICATIONS

A. Install the following types of electric heating cable for the applications described:

1. Snow and Ice Melting on Roofs and in Gutters and Downspouts: Self-regulating, parallel-resistance heating cable.
2. Temperature Maintenance for Domestic Hot Water: Self-regulating, parallel-resistance heating cable.

3.3 INSTALLATION

A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.

B. Electric Heating-Cable Installation for Snow and Ice Melting on Roofs and in Gutters and Downspouts: Install on roof and in gutters and downspouts with clips furnished by manufacturer that are compatible with roof, gutters, and downspouts.

C. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install electric heating cables according to IEEE 515.1.
3. Install insulation over piping with electric cables according to Section 220719 "Plumbing Piping Insulation."
4. Install warning tape on piping insulation where piping is equipped with electric heating cables.

D. Electric Heating-Cable Installation for Temperature Maintenance for Domestic Hot Water:

1. Install electric heating cables after piping has been tested and before insulation is installed.
2. Install insulation over piping with electric heating cables according to Section 220719 "Plumbing Piping Insulation."
3. Install warning tape on piping insulation where piping is equipped with electric heating cables.

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

3.4 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

C. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

D. Cables will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION 220533

SECTION 221100

PLUMBING GENERAL

Part 1 GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SCOPE

A. Work consists of furnishing all labor, material, equipment and services necessary and reasonably incidental to the proper completion and proper operation of the plumbing systems. The work shall consist of but shall not necessarily be limited to the following:

1. Domestic water system including extension of piping and connections to all equipment, fixtures, booster pumps, water heaters, and accessories. The Domestic water system shall be extended from a point 5 (five) feet beyond the exterior face of the building. Provide a water meter and backflow preventor in accordance with local water company requirements.

2. Sanitary drain, waste and vent system including connection to all equipment, fixtures, and accessories. The sanitary system shall be extended to a point 5 (five) feet beyond the exterior face of the building. Final installation at the point of connection shall be made.

3. Modifications to existing plumbing systems, equipment, fixtures, and accessories as indicated and as specified.

4. Disconnection and removal of existing plumbing systems, equipment, piping, etc., no longer required as a part of the revised installations.

5. Piping and equipment insulation for existing systems and equipment which have been exposed due to an asbestos abatement program.

1.3 DEFINITIONS

A. Words and phrases used throughout the Contract Documents shall be interpreted as indicated below:

1. Contractor - The person or organization awarded the contract for construction services. In the case of a construction project administered as a multiple-prime contract, the term shall be further defined as the Contractor holding a prime contract for plumbing construction work.

2. Provide - To furnish and install materials, equipment or systems.

3. Submittals - Submittals shall include Manufacturer's Catalog Data, Shop Drawings, Calculations, Certificates of Compliance, Testing Reports, Samples, and Operation and Maintenance Manuals.

4. Professional - The Architect and/or Engineer of record.

5. Work By Others - Work provided by a person or organization other than the Contractor.

1.4 CODES, REFERENCES AND STANDARDS

A. The Contractor shall comply with all laws, ordinances, and regulations of all Authorities Having Jurisdiction, including Township, Borough, City, County, State, Federal and Public Utility. All licenses, permits, fees, connection fees, tapping fees, inspection fees, etc., shall be obtained by the Contractor and the cost shall be included in the Contract price.

B. The minimum standard of work under this contract shall be in accordance with the following model building codes:

International Building Code (2015)
International Plumbing Code, (2015) - (with local amendments)
International Fire Protection Code - current edition. (with local amendments)

C. The publications listed below form a part of this specification to the extent referenced. All publications shall be the latest edition as adopted by the Authority Having Jurisdiction. The publications are referred to in the text by basic designation only.

1. American Association of State Highway and Transportation Officials (AASHTO)

   333 N. Capitol St. NW
   Washington, D.C. 20001

   a. AASHTO T99

   b. AASHTO T 191.

2. American Concrete Institute (ACI)

   Box 19150, Retford Station
   Detroit, MI 48219

   a. 301

   b. 315

   c. 318

3. American National Standards Institute (ANSI)

   11 W. 42nd St.
   New York, New York 10036

   American Water Works Association (AWWA)
   6666 West Quincy Avenue
   Denver, Colorado 80235

   a. Cement Mortar Lining for Ductile-Iron Pipe — ANSI A21.4 — AWWA C104

   b. Rubber Gasket Joints for Ductile-Iron Pipe — ANSI A21.11 — AWWA C111

c. Ductile-Iron Pipe ANSI A21.51 AWWA C151

d. Cast Iron Screwed Fittings ANSI B16.4

e. Cast Iron Drainage Fittings, Threaded ANSI B16.12

f. Pipe Fittings, Bronze, and 250 lb. Cast ANSI B16.15

g. Cast Copper Allow Solder-Joint Pressure Fittings ANSI B16.18

h. Solder-Joint Fittings, Pressure Wrought Copper and Copper Alloy ANSI B16.22

i. Cast Copper Alloy Solder-Joint Drainage Fittings ANSI B16.23

j. Bronze Pipe Flanges and Flanged Fittings ANSI B16.24

k. Solder-joint fittings, Drainage, DWV Wrought ANSI B16.29
Copper and Copper Alloy ANSI B31.1

l. Gas Water Heaters ANSI Z-21-10.3

4. American Petroleum Institute (API)

1220 L St. NW
Washington, D.C. 20005

a. Bulletin #1604

b. Bulletin #1615

c. Bulletin #1632

5. American Society of Heating Refrigeration (ASHRAE) and Air Conditioning Engineers

1791 Tullie Circle NE
Atlanta, GA 30329

a. Ashrae 90A

6. American Society of Mechanical Engineers (ASME)

345 East 47th Street
New York, New York 10017

a. Cast Copper Alloy Fittings for Flared Copper Tubes ASME B16.26

b. ASME Boiler and Pressure Vessel Code.

(1). Section IV Low Pressure Heating Boilers.

(2). Section VIII, Unfired Pressure Vessels.

7. American Society of Testing and Materials (ASTM)

1916 Race Street

Philadelphia, PA 19103

a. Cast Iron Soil Pipe and Fittings Hub and Spigot — ASTM A74

b. Seamless Copper Water Tube — ASTM B88

c. Copper Tube, Drainage DWV — ASTM B306

d. Recommended Practices for Laying Sewer Pipe — ASTM C-12

e. PVC Pipe - Schedule 40 — ASTM D1785

f. Pipe Fittings, PVC, Schedule 40 — ASTM D2466

g. ASTM D1557, Method D and ASTM D1556
Sand Cone Method

h. Billet-Steel Bars for Concrete Reinforcement, — ASTM Spec. A-6l5

8. Cast Iron Soil Pipe Institute (CISPI)

5959 Shallow Ford Road
Suite 419
Chattanooga, TN 37421

a. Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems — CISPI301

9. Compressed Gas Association (CGA)

a. Pamphlet P-2.1

10. Manufacturer's Standardization Society (MSS)

5203 Leesburg Pike, Suite 502
Falls Church, VA 22041

a. Unions, Brass or Bronze, 250 pounds — MSS-SP-72

11. National Fire Protection Association (NFPA)

1 Batterymarch Park
Quincy, MA 02269

a. Flammable and Combustible Liquids Code — NFPA 30

b. National Fuel Gas Code — NFPA 54

c. National Electrical Code — NFPA 70

d. Health Care Facilities — NFPA 99

e. Handling Underground Releases of Flammable and Combustible Liquids — NFPA 329

12. Occupational Safety and Health Administration (OSHA)

    Department of Labor
    200 Constitution Avenue NW
    Washington, D.C. 20590

    a. 29 CFR 1926/1910

13. Commonwealth of Pennsylvania

    a. Department of Labor and Industry

    b. Regulations Governing Boilers and Unfired Pressure Vessels 34 PA Code, Chap 3
    State Energy Conservation Code.

    c. Commonwealth of Pennsylvania State Police Fire Marshall Division Title 37 LAW.

    d. Commonwealth of Pennsylvania Storage Tank and Spill Prevention Act.

    e. Department of Transportation 67 PA Code - Chapter 401 and 459

14. Plumbing Draining Institute (PDI)

    5342 Boulevard Place
    Indianapolis, IN 46208

    a. Shock Absorbers PDI WH 201

15. Underwriter's Laboratories, Inc. (UL)

    333 Pfingsten Rd.
    Northbrook, IL 60062

    a. UL58-1976.

16. United States Government

    a. Federal Register - Technical Standards for UST's Part 280 and 281.

1.5 QUALITY ASSURANCE, WORKMANSHIP AND COORDINATION

A. The Contractor must coordinate his work with that of the other trades so that the all will be performed in an orderly manner and with the least possible interference. Where coordination with other trades is required, the Professional shall make the final decision regarding changes to be made in the work.

B. The Contractor must thoroughly familiarize himself with all specifications and drawings for the project so that he clearly understands his responsibility in relationship to the work to be performed. The Contractor must plan and perform his work so as to permit the use of the building at the earliest possible date.

C. The Contractor shall guarantee the workmanship, materials and equipment, furnished against defects, leaks, performance and non-operation for a period of one (1) year after the date of final acceptance. Defective workmanship shall be construed as meaning defective materials and unsatisfactory installation and not intended to apply to ordinary wear and tear. The Contractor shall

pay for any repairs or replacements caused by defective workmanship as construed herein within the period covered by the Guarantee, including all incidental work required to correct the deficiency.

D. The Contractor will be held responsible for the proper installation of all materials and equipment required for a complete installation within the intent and meaning of the Contract Documents.

1.6 PROJECT RECORD DRAWINGS

A. Changes from the Contract Drawings necessary to coordinate the work with other trades, to conform to the building conditions or to conform to the rules and regulations of Authorities Having Jurisdiction shall be made only after obtaining written permission from the Professional.

B. The Contractor shall keep a record of construction changes and deviations from the original Contract Drawings. All changes shall be recorded on a separate set of prints which shall be kept at the job site specifically for that purpose. The record shall be made immediately after the work is completed. Documentation shall include:

1. location and elevation of new and existing utility lines

2. points of connection to existing utility lines

3. changes in pipe routing location

4. valve locations

5. equipment locations, etc.

C. The marked-up record set of drawings shall be delivered to the Professional before final acceptance of the Plumbing Contract work.

1.7 FIELD MEASUREMENTS

A. It shall be the Contractor's responsibility to verify the location of any and all existing underground utilities in the vicinity of his work. When it has been indicated that these utilities are to remain in place, the Contractor shall provide adequate means of support and protection during excavation operations.

B. Before ordering any equipment and material, or performing any work, the Contractor shall verify all measurements and dimensions at the job site and shall be held responsible for the correctness of same.

C. No extra compensation will be allowed on account of differences between actual dimensions and measurements and those indicated on the drawings.

D. Any difference which may be found shall be submitted to the Professional for consideration before proceeding with the work.

1.8 PROTECTION OF SERVICES AND EQUIPMENT

A. The Contractor, at his own expense, shall repair, replace and maintain in service any utilities, facilities or services (underground, aboveground, interior or exterior) damaged, broken, or otherwise rendered inoperative during the course of construction due to activities on the part of the Contractor.

The method used by the Contractor in repairing, replacing or maintaining the services shall be approved by the Professional.

B. The Contractor shall protect, at his own expense, such of his work, materials or equipment that is subject to damage during the project duration. All openings into any piping, ducts or equipment must be securely covered, or otherwise protected, to prevent injury due to carelessly or maliciously dropped tools or materials, grit, dirt, or any foreign material. The Contractor shall be held responsible for all damage so done until his work is fully and finally accepted.

C. It shall be the responsibility of the Contractor to protect motors, pumps, electrical equipment, and all similar items of equipment from dirt, grime, plaster, water, etc. during all phases of construction. This protection shall be provided by covering equipment with transparent plastic sheeting and/or locating the materials and equipment in an area free from the elements.

1.9 INTERRUPTION OF SERVICES

A. The Contractor shall schedule his work to avoid any major interruption of any utility services.

B. Existing utilities serving facilities occupied and used by the Owner or others shall not be interrupted except when such interruptions have been authorized in writing by the Owner or the Professional. Interruptions shall occur only after acceptable temporary utility services have been provided. The Contractor shall provide a minimum of ten (10) working days notice to the Professional and receive written notice to proceed before interrupting any utility.

1.10 CLEANUP

A. The Contractor shall maintain buildings, grounds and public properties free from accumulations of waste materials, debris and rubbish. At reasonable intervals during the progress of work, and when directed by the Owner's Authorized Representative, the site and public properties shall be cleaned and waste materials, debris and rubbish shall be disposed of in appropriate manner. The Contractor shall provide containers for collection of waste materials, debris and rubbish. Waste materials, debris and rubbish shall be removed from the job site and legally disposed of at a landfill area in accordance with all applicable regulations. Burning or burying waste materials, debris or rubbish on project site shall not be permitted.

B. At the completion of the Project, remove waste materials, rubbish, tools, equipment, machinery, surplus materials, etc., and clean all sight-exposed plumbing fixtures and equipment. Remove grease, dust, dirt, stains, labels, fingerprints and other foreign materials from sight-exposed plumbing fixtures and equipment. Broom clean paved and concrete surfaces; rake clean other ground surfaces. Repair, patch and touch up marred surfaces to specified finish or to match adjacent surfaces.

1.11 CONCRETE

A. Reinforcing shall conform to ASTM A-6l5, Grade 60. Concrete exposed to freezing and thawing, salts, sulfates and corrosion shall comply with BOCA National Building Code.

B. All concrete shall be of minimum 3000 pounds per square inch (psi) strength in 28 (twenty-eight) days. All concrete shall be mixed by machine. No wet or moistened mixture containing cement shall remain unplaced for a period exceeding 30 (thirty) minutes and shall not be used after its initial set. Retempering after initial set is prohibited. Exposed surfaces shall be protected from drying for

at least 7 (seven) days. All forms shall be built true and rigid. Form removal shall not injure the concrete.

C. All concrete is to be finished with a hard, smooth troweled finish and is to be faced smooth with rounded corners.

1.12 INSPECTION AND TESTING

A. General

1. New plumbing systems and parts of existing systems which have been altered, extended or repaired shall be tested to disclose leaks and defects.

2. The Contractor shall notify the Professional a minimum of 5 (five) working days prior to testing to coordinate the testing and inspection procedures.

3. If the Professional determines that the plumbing systems do not pass the prescribed tests, then the Contractor shall be required to make the necessary repairs, at his own expense, and the Contractor shall re-inspect and re-test the systems. Repairing, inspection and testing shall be continued until all systems pass as determined by the Professional.

4. All new, altered, extended or replaced plumbing shall be left uncovered and unconcealed until it has be inspected, tested and accepted by the Professional. Where such work has been covered or concealed before it has been inspected, tested and accepted, it shall be uncovered by the Contractor, at his own expense as directed by the Professional.

5. All equipment, material, labor, etc., required for testing the plumbing systems shall be furnished by the Contractor.

B. Sanitary, Vent, and Rainwater Collection Systems

1. Rough Plumbing - Systems shall be tested upon completion of the rough piping installation and proved watertight. The water test shall be applied to the system either in its entirety or in sections after rough piping has been installed.

a. Where applied to the entire system, all openings in the piping shall be closed, except the highest opening, and the system filled with water to point of overflow.

b. Where the system is tested in sections, each opening shall be plugged, except the highest opening of the section under test, and each section shall be filled with water. A section shall not be tested with less than a 10-foot head of water.

c. In testing successive sections, at least the upper 10-feet of the next preceding section shall be tested, such that a joint or pipe in the building, except the uppermost 10 feet of the system, shall not have been subjected to a test of less than a 10-foot head of water.

d. The water shall be kept in the system or in the portion under test for a minimum of 2 (two) hours before inspection starts. The system shall then be inspected to ensure that it is tight at all points.

2. Finished Plumbing - After the plumbing fixtures have been set and their traps filled with water, the plumbing fixture connections shall be tested and proved gas and watertight.

a. A smoke test shall be made by filling all traps with water and then introducing into the system smoke produced by one or more smoke machines. When the smoke appears at stack openings on the roof, the stack openings shall be closed and a pressure equivalent to a 1-inch water column shall be introduced and maintained for the period of the inspection.

b. Where the local Authority Having Jurisdiction finds that a smoke test need not be performed, a peppermint test shall be performed. Two (2) ounces of oil of peppermint shall be poured into the roof terminal of every line or stack to be tested. The oil of peppermint shall be followed at once by 10 quarts of hot (140-degrees Fahrenheit) water. All roof vent terminals shall then be sealed. The system shall then be inspected for the detection of odor of peppermint. If odor of peppermint is detected, repairs shall be made, and the system shall be retested.

C. Building Sewer

1. The building sewer shall be tested by insertion of a test plug at the point of connection**.** The building sewer shall then be filled with water under a head of not less than 10-feet. The water level at the top of the test head of water shall not drop for at least 15 (fifteen) minutes.

D. Domestic Water Systems

1. The system shall be tested either in its entirety or in sections.

2. The system shall be tested and proved tight under a water pressure of 125 pounds per square inch for a period of 2 hours.

3. Potable water shall be used for testing.

E. Fuel Gas Systems

1. All fuel gas piping shall be pneumatically tested for tightness prior to commencement of gas service. Air or nitrogen shall be used as the test medium. The piping system shall be pressurized to 100 psig for a period of 2 hours. All joints shall be leak tested with detection solution while the system is pressurized. The Contractor shall provide a valved 1/4-inch FPT connection in the system to which shall be attached a 24 hour pressure recording gauge. The Contractor shall arrange for a gas company representative to witness the test. Leaks shall be repaired by tightening or replacing joints. Caulking of joints is not permitted.

F. Compressed Air Systems

1.13 STERILIZATION OF THE DOMESTIC WATER SYSTEM

A. After the system has been tested and approved, the entire new system, including valves and accessories, shall be chlorinated. Disinfection to be in accordance with AWWA C651.

B. Chlorine may be applied in any of the following forms:

1. Liquid chlorine gas-water mixture

a. Chlorine gas-water mixture shall be applied by a solution feed chlorinating device.

2. Direct chlorine gas feed

a. Chlorine gas shall be fed directly from a chlorine cylinder with a suitable device for regulating the rate of flow and the effective diffusion of gas within the line.

3. Calcium hypochlorite and water mixture.

a. Calcium hypochlorite shall be HTH, Perchlorene and Maxochlor, or accepted substitute. A solution consisting of five (5%) percent powder to ninety-five (95%) percent water by weight shall be prepared. The calcium hypochlorite and water mixture, first made into a paste and then thinned to a slurry, shall be injected or pumped into the system.

C. Water shall be fed into the system with chlorine applied in amounts to produce a dosage of 40 to 50 parts per million (ppm) and shall be retained in the line for a period of not less than 8 hours. A residual of not less than 5 ppm shall be produced in all parts of the line. During the chlorination process all valves and accessories shall be operated.

D. After the chlorination process, the chlorine shall be flushed from the system until the system water is equal chemically and bacteriologically to those of the permanent source of water supply.

E. Laboratory tests of the water shall be paid for by the Contractor.

1.14 INSTRUCTION OF THE OWNER

A. After acceptance of the Project, the Contractor shall furnish the services of personnel thoroughly familiar with the completed installation to instruct the Owner in the proper operation and maintenance of all equipment and appurtenances provided.

B. The Contractor shall provide the Owner with two weeks advance notice before the instruction session.

1.15 DEMOLITION

A. The Contractor shall disconnect and remove all plumbing equipment, materials, fixtures and existing services no longer required, unless noted otherwise. All exposed piping shall be removed and capped either below floors, in walls or above ceilings as may be required. All materials used for capping of existing services shall be fully compatible with existing piping materials and appropriate for the pressure involved.

B. Removal shall include the removal of materials from the site and the proper disposal of such material, unless noted otherwise.

C. Materials to be retained by the Owner shall be stored in a suitable location, as directed by the Owner, clear of any access corridors and clear of all new work.

D. All demolition shall be made in a neat, workmanlike manner so as not to damage any surfaces or equipment to remain.

E. Demolition of piping shall include the removal of existing hangers and similar items not to be reused. Demolition of equipment shall include the removal of anchors and similar items not be reused.

F. The Contractor shall patch and finish all holes associated with the demolition work. All patching and finishing shall match existing adjacent undisturbed surfaces to the satisfaction of the Professional.

1.16 CUTTING, PATCHING, FINISHING (EXISTING BUILDING)

A. Unless otherwise noted, the Contractor shall cut, patch and finish all chases and openings required for the installation of work to be performed under this Contract. All patching and finishing shall match existing adjacent undisturbed surfaces.

B. Cutting shall not cause damage to the building or leave unsightly surfaces. Where such unsightly conditions are caused by the Contractor, he shall be required to repair these.

C. The Contractor shall contact the holder of the guarantee and obtain written approval before cutting the roofing membrane so as not to void said guarantee.

D. No structural member shall be cut.

E. Penetrations made in existing fire rated chases, partitions, floors, etc. shall be sealed with an approved material and method as required to maintain the integrity of the fire separation.

F. All materials and methods to be used for patching and repairing shall be subject to the approval of the Professional and the Owner's Authorized Representative.

G. The Contractor shall set all sleeves, hangers, and anchors required for the Plumbing Contract work and shall be responsible for their proper and permanent location.

H. No cutting shall be done which may affect the building structurally or architecturally without first securing the approval of the Professional. Cutting shall be accomplished in such a manner as not to cause damage to the building or leave unsightly surfaces which cannot be concealed by plates, escutcheons or other construction. Where such unsightly conditions are caused, the Contractor shall be required, at his own expense, to repair the damaged areas.

I. Cutting of the construction excessively or carelessly done shall be repaired to match the original work by the Contractor and to the satisfaction of the Professional who will make the final decision with respect to excessive or careless cutting work. The Contractor shall seal all openings he has made in plenum spaces, fire rated floors, ceilings or partitions after his work has been installed. The material used for sealing the openings shall have a fire rating equal to or greater than the rating of the floor, ceiling or partition material.

J. Where present equipment is removed and unused openings remain in walls, floors, partitions, etc., the Contractor shall properly patch all such openings except as hereinafter specified under "Work by Others." All patching and repairing shall be done by workmen skilled in this type of work and shall match present or new finishes.

K. Cutting, patching, and repairing of openings in the existing exterior walls and roof shall be by the General Contractor.

1.17 CHASES AND OPENINGS

A. All chases and openings required for the installation of the work shall be coordinated with the other trades. The Contractor shall provide the other trades with sufficient time (1 (one) week minimum)

for coordination of all chases and openings. The Contractor shall be responsible for all work required to cut and patch the required openings. The work shall be performed to the satisfaction of the Professional.

B. Penetrations made in fire rated chases, partitions, floors, etc. shall be sealed with an approved material and method as required to maintain the integrity of the fire separation.

C. The Contractor shall provide all sleeves, hangers, and anchors required for installation of the work in chases and openings.

1.18 WATER SERVICE AND METERS

A. The Contractor shall provide water meters in accordance with the local water utility requirements, including required permits, meters, piping, valves, bypasses, supports and other accessories.

1.19 RELATED WORK

A. All work related to providing complete plumbing systems and equipment shall be the responsibility of the Contractor. The following related work shall be provided as indicated in other specification Divisions, unless noted otherwise, but shall remain the responsibility of the Contractor for workmanship and completeness:

1. General Contractor

a. Installation of access panels.

b. Leaders and gutters.

c. New catch basins and foundation drains. Final connections shall be by the Contractor, as indicated on the drawings and as herein specified.

d. Final painting of existing walls, floors and ceilings where the surfaces are being refinished and remodeled under the General Contract. Refer to General Construction Drawings.

e. Equipment and furnishings. Final connections to all equipment and furnishings shall be provided by the Contractor. The Contractor shall be responsible for coordination of plumbing services with the equipment and furnishings.

f. Casework mounted sinks and lavatories, including faucets, bubblers, strainers, tailpieces, traps, gas cocks, and inter-connecting piping. The Contractor shall install the sinks, equipment and appurtenances and shall make final plumbing connections. Rough-in plumbing work shall be in accordance with rough-in drawings as furnished by the General Contractor. Final connections to all fixtures shall be provided by the Contractor. The Contractor shall be responsible for coordination of plumbing services with the fixtures and equipment.

g. Mop receptors

h. Concrete housekeeping pads for plumbing equipment.

i. Removal of existing concrete housekeeping pads.

2. Mechanical Contractor

    a. Roof ventilators and air conditioning equipment. Condensate drain lines and final drain connections to equipment shall be provided by the Contractor.

    b. Condensate drain piping.

3. Electrical Contractor

    a. Verification of the proper rotation of three phase equipment and making modifications as required to correct improper rotation.

    b. Installation of all combination starters/disconnects and overload protectors.

1.20 MISCELLANEOUS STEEL AND ACCESSORIES

A. The Contractor shall provide all necessary steel angles, channels, pipe, rods, nuts, bolts, etcetera, as shown on plans, as specified, or as may be required for complete and proper installation of plumbing fixtures, systems and equipment. All material and workmanship shall be of the best quality and shall be installed in accordance with the best practices of the trade.

1.21 ACCESS PANELS

A. The Contractor shall furnish access doors to the General Contractor for installation in ceilings, walls, partitions and floors for access to valves, traps, fittings, and all appurtenances.

B. Access panels shall be of sufficient size to permit removal or access to equipment, except that the minimum size shall be 12-inches by 16-inches.

C. Access door locations shall be as determined by field conditions for optimum access to equipment, and shall be reviewed by the Professional before final installation, and shall be subject to the following:

D. Bottom of access doors shall not be lower than the top of the partition base, or a minimum of 6 inches above floor.

E. Tops and/or sides of access panels shall be a minimum of 6-inches from the ceiling or opening or from the edge of a wall return.

F. Access doors shall be suitable for installation in the finish material of the ceilings, walls, partitions and floors.

G. Frame and panel access doors in restrooms, kitchens and as indicated shall be stainless steel.

H. Access doors with UL Listing shall be provided in rated construction assemblies. Access doors shall be "B-Label" and shall have a UL one and one-half (1-1/2) hour rating at 250 degrees F rating for both door and frame. Maximum size shall be 20" x 20" or 400 square inches in area. Frame shall be sixteen (16) gauge minimum steel, panel shall be twenty (20) gauge minimum steel. Access doors shall be provided with a baked-on enamel finish (prime coat), continuous type hinge on one side, flush-face type lock with key operation and self-latching cylinder locks.

I. Access doors without UL label shall be provided in all non-rated construction assemblies: Frame shall be sixteen (16) gauge minimum steel, panel shall be fourteen (14) gauge minimum steel. Access doors shall be provided with a baked-on enamel finish (prime coat), concealed spring type hinges and flush-face type lock with key operation and self-latching cylinder locks. Door shall open 175 degrees (minimum).

J. All access doors shall be keyed alike.

Part 2 PRODUCTS

2.1 GENERAL

A. All materials used on plumbing systems shall comply with the following lead ban requirements:

B. Solders with lead content exceeding 0.2% (two-tenths of a percent) are prohibited. Brass and bronze materials containing 8.0% (eight percent) or greater lead are prohibited.

Part 3 EXECUTION

A. All materials and equipment used shall be installed in strict accordance with the Standards under which the materials are accepted and approved, and in strict accordance with the manufacturer's instructions.

B. The Contract Documents are not intended to indicate every bend, offset, change in direction and appurtenance required to provide a complete and workable system.

C. The contract drawings are diagrammatic and are indicative of the work to be performed. It is not intended that they show every pipe, fitting or apparatus required for a complete installation.

D. Except where otherwise indicated, minimum cover shall not be less than the following:

1. sanitary sewer piping: 3'-6"

2. storm sewers: 1'-0"

3. water piping: 4'-0"

4. gas piping: 2'-0"

END OF SECTION

SECTION 221110

PLUMBING PIPING

Part 1 GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SECTION INCLUDES

A. The provisions and requirements of the following sections apply to work in this section.

1. Plumbing General

B. Work in this Section includes the following:

1. Interior domestic water piping systems
2. Interior sanitary drainage piping systems
3. Compressed air piping systems
4. Fuel gas piping systems
5. Sleeves and floor plates
6. Supports, hangers, inserts and fasteners
7. Expansion compensators and guides
8. Valves
9. Pipe insulation
10. Pipe identification
11. Valve tags
12. Utility marking tape

1.3 SUBMITTALS

A. The Contractor shall submit manufacturer's catalog data for the following:

1. Interior domestic water piping systems

2. Interior sanitary and stormwater drainage piping systems

3. Fuel gas piping systems

4. Hangers and supports

5. Insulation

6. Expansion compensators and guides

7. Valving

8. Plumbing piping Identification

1.4 GAS UTILITY COMPANY COORDINATION

A. The Contractor shall verify the requirements for the gas service with the Gas Utility Company before starting work.

B. The Contractor shall include in his bid price the cost to obtain, furnish and install the gas meter regulators, associated concrete pads, piping, supports and valves required by the Gas Utility Company as a condition to provide service.

Part 2 PRODUCTS

2.1 INTERIOR DOMESTIC WATER PIPING (WITHIN 5 FEET OF BUILDING)

A. Water piping above grade shall be Type "L" hard temper copper tubing conforming to ASTM B88, with cast bronze or wrought copper solder end fittings, conforming to ANSI B16.18, ANSI B18.24 or ANSI B16.22.

B. Water piping below grade, 1/2 inch through 2-1/2 inches shall be Type "K" copper tubing with brazed cup depth sockets fittings ASNI/ASME B16.50. Water piping 3 inches and larger shall be Ductile Iron pressure pipe Class 52 cement lined with mechanical or push-on joint ANSI Spec. A21.51 with A21.11 gaskets and mechanical joint fittings.

C. All solder joints in copper tubing shall be made with 95-5 tin-antimony solder. Use of lead solder will not be permitted.

2.2 INTERIOR SANITARY AND STORMWATER DRAINAGE PIPING (WITHIN 5 FEET OF BUILDING)

A. Above Ground Sanitary Waste, Vent Piping - Sanitary waste, vent inside buildings above ground shall be service weight cast iron conforming to ASTM A74/ASTM A888. Fittings shall be drainage pattern type. Pipe & Fittings shall be AB&I, Charlotte or Tyler and joints as manufactured by Clamp-all-125, Husky SD 4000 or MG. No-Hub piping shall be supported per CISPI Handbook Chapter IV. Threaded cast iron drainage fittings shall conform to ANSI B16.12. Type DWV hard drawn copper tube conforming to ASTM B306 with ANSI B16.29 DWV wrought copper or ANSI B16.23 cast copper fittings with 95-5 tin-antimony solder.

B. Below Ground Sanitary Piping - All underground sanitary and rainwater conductor piping inside the building to a point 5 feet outside the face of exterior walls shall be service weight cast iron soil pipe

conforming to ASTM A74. Extra heavy cast iron pipe shall be used where required by local code. Fittings shall be drainage pattern, neoprene compression type conforming to ASTM C 564.

2.3 FUEL GAS PIPING

A. Interior gas piping shall be Schedule 40 black steel pipe with malleable iron fittings and threaded joints. Underground piping and piping 4 inch and larger shall be Schedule 40 black steel with forged steel butt welded fittings. Underground piping shall be factory coated with a resilient polyethylene sleeve, twenty-five (25) mils thick sealed to the pipe.

B. Exterior underground piping may be SDR11 polyethylene, (PB2306/PE2405) conforming to ASTM D253, with heat fusion or mechanical joints, if acceptable to the gas company. Submit as a shop drawing, a letter from the gas company confirming their approval of this system.

2.4 COMPRESSED AIR PIPING

A. Type "L" copper tubing, ASTM B88, wrought copper fittings, 95-5 tin antimony solder.

B. Black Steel, ASTM A53, Schedule 40, malleable iron or cast-iron threaded fittings, carbon steel ASTM -234 weld fittings.

2.5 VALVES

A. All valves shall be products regularly produced for the specified service and rating in accordance with the manufacturer's catalog or engineering data. All valves shall be marked with the manufacturer's name or trademark. The recommended service pressure and the size, by letters and figures, cast or stamped on the body of the valve. Lead content in brass and bronze used in valves for plumbing systems shall not exceed eight (8) percent.

B. Domestic Hot and Cold Water Valves

1. Ball Valves

a. 2-1/2-inch and Smaller - 600 psi WOG, lead free, full port, three piece, bronze body, stainless steel ball and stem NIBCO T595Y Series, threaded end; Nibco S595Y Series, sweat ends.

b. 3-inch and Larger - Conventional port, three (3) piece, NIBCO S590Y or T590Y.

2. Fuel Gas Valves

a. Gas Shutoff Valve - Gas valves shut off purposes shall be cast iron body eccentric action plug type with resilient plug facings composed of nitrile butadiene. 1/2 inch to 4 inch size shall be DeZurik Fig. 425 with lever operators. Greater than 4" size shall be handwheel actuated DeZurik Fig. 118.

b. Gas Solenoid Valve - Explosion proof, normally closed, with a NEMA 1 enclosure, UL listed gas solenoid valve. Aluminum body, Buna N seat and disc valve shall be rated for 120V operation. All switches, wiring, etc. for valve shall be provided as indicated in Division 26. Solenoid valve shall be ASCO Model 8215.

2.6 SLEEVES AND FLOOR PLATES

A. Sleeves through interior partitions shall be galvanized sheet metal and shall be provided with means for holding the sleeve securely in the penetrated construction. Exposed sleeves shall have a chrome plated floor or ceiling plate escutcheon securely fastened around pipe. Where pipe is covered or insulated, escutcheon shall fit over covering.

B. Sleeves through foundation walls and waterproofed floor slabs shall be of the waterproof type and shall be provided with waterproof seals. Waterproof seals shall be molded rubber construction, designed to be expanded radially by mechanical compression. Waterproof seals shall be linkseals as manufactured by Thunderline Corporation.

C. Penetration sealant fire stopping system shall be a mixture of fusible ceramic firebreak material, water releasing hydrates, gas producing cenospheres, and a binder resin containing essentially no corrosive halogens, no asbestos and no glass fiber making the compound intrinsically safe under adverse fire conditions. Under fire conditions, the material shall form a vitrified surface coating acting as an effective refractory barrier. The cenospheres contained in the mixture swell when exposed to high heat, releasing inert nitrogen and carbon dioxide gases. Penetration sealant shall flow free under pressure of agitation and thicken when in place. Penetration sealant shall remain permanently pliable after curing. Penetration sealant shall be "Flame Safe" Fire Retardant as manufactured by Thomas and Betts Corporation.

D. Mechanical type fire stopping system shall conform to UL-1479 and ASTM E119 test standards. Assemblies shall have fire ratings consistent with the floor or wall assembly rating shown on the plans. Copper and steel piping shall utilize Proset System "A" penetration system. Cast iron piping shall utilize Proset System "B" penetration system.

2.7 SUPPORTS, HANDERS, INSERTS AND FASTENERS

A. Hanger Materials

1. Products shall be as manufactured by B-Line, Grinnell Company or Crane Company. Model numbers are Grinnell and are provided for reference.

2. Provide all steel required for support of pipes and equipment other than steel shown on Structural Engineer's drawings.

3. All steel hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, brackets, shall be dipped in Zinc Chromate Primer before installation, or furnished from the factory in this manner.

4. Hangers for use on uninsulated copper piping shall be provided with inserts to isolate the copper piping from the hanger. Inserts shall be made of felt or plastic and shall be as manufactured by the hanger manufacturer.

5. Horizontal Waste, Vent Piping:

a. 3 inch and smaller: Figure No. 260.

b. 4 inch and larger: Figure No. 590.

6. Storm Water Piping:

a. All sizes: Figure No. 590.

7. Horizontal Domestic Water Piping:

a. 2 inch and smaller: Figure No. 260 with 6 inch metal shield.

b. 2-1/2 inch and larger: Figure No. 260 with 12 inch metal shield.

8. Vertical Piping (Riser Clamps):

a. Copper Pipe: Figure No. CT-121C, copper plated with plastic coated formed portion.

b. Steel Pipe: Figure No. 261, galvanized.

9. Connectors:

a. For bolt-on locations to structure, No. 88, 133, 134 or 292S.

b. For concrete spot inserts at single locations for casting into structure No. 282 or 285 for pre-determined rod size and No. 186 for universal use.

c. Welded beam attachments, Figure No. 66.

d. Piping adjacent to walls or steel columns, brackets No. 194, 195, or 199, depending on weight to be supported.

e. Base supports, Figure No. 259, or 264.

10. Hanger Rods:

a. Hanger rod, Figure No. 140.

b. Continuous threaded rod, Figure No. 146.

c. Eye Rods, Figure No. 248.

11. Trapeze Hangers - Direct Mounting Hangers:

a. Figure No. 46.

12. Spring Hangers:

a. Light loads, movement less than 1/4 inch, Figure No. 247.

b. Medium loads, movement 1/4 inch or 3/4 inch, Figure No. 268.

c. Heavy loads, movement exceeding 3/4 inch, Figure No. 268.

13. Protection Saddles

a. Insulated pipe supports, calcium silicate insulation with galvanized sheetmetal jacket - Figure No. 167.

14. Horizontal AWWA Pipe (Flanged or Bell-Spigot

a. Cast iron pipe, No. 590.

2.8 PIPE INSULATION

A. All insulation shall have composite surface burning characteristic ratings as tested by ASTM E 84, UL 723, or NFPA 255 not exceeding:

1. Flame Spread 25

2. Smoked Developed 50

B. Composite shall include insulation, jacketing and adhesive used to secure jacketing or facing. All accessory items such as PVC Jacketing and Fittings, adhesive, mastic, cement, tape and cloth shall have the same component rating as specified above.

C. Insulation shall be molded one (1) piece with a maximum thermal conductivity of 0.23 BTU-in./hr-sq. ft.-°F at seventy-five (75) degrees F mean temperature.

D. Insulation shall be heavy density fiberglass, ASJ/SSL-II as manufactured by Owens-Corning Fiberglass Corp. Johns Manville or accepted substitute. Valve and fitting covers shall be Zeston 2000 PVC fitting covers as manufactured by Manville Co. Mastic sealer shall be Foster Tite-Fit Coating 30-35 as manufactured by H.B. Fuller Company.

E. Closed cell foam insulation of 1 inch thickness or .ess may be substituted for fiberglass type sealed with compatible adhesives. Insulation shall by Model AP Armaflex as manufactured by Armstrong.

2.9 VALVE TAGS

A. Tags shall be brass, 1" in diameter with large stamped numerals and attached by a short link brass chain or brass "S" hook.

2.10 UTILITY MARKING TAPE

A. Minimum 2 inches wide, metalized core plastic foil with the words "Caution - Pipeline Buried Below" printed in bold black letters.

Part 3 EXECUTION

3.1 GENERAL

A. All materials, equipment and accessories specified in this section shall be installed in strict accordance with the manufacturers' recommendations.

3.2 PIPING INSTALLATION

A. General

1. All piping in finished areas shall be run concealed. The Contractor shall furr in piping or provide soffiting as required and in accordance with the Professional's instructions. All piping shall be installed as required to suit space available in building structure, above suspended ceilings, and other locations found necessary for installation. Install piping as high as possible.

2. The Contractor shall not install any piping that will interfere with any lights, openings, doors, windows, ductwork, equipment, and existing or special conditions. Headroom in front of openings, doors, or windows shall not be less than the top of the opening. Provide all piping offsets necessary to avoid interferences with other work. Piping offsets shall include all devices and assemblies necessary to accommodate the change in direction of the piping.

3. All piping shall run straight with no more couplings and joints than necessary, shall be grouped wherever practical and shall be carefully installed to provide for proper alignment slope and expansion.

4. Pipes carrying fluids shall not be installed in transformer vaults, electrical equipment rooms, elevator hoistways, elevator equipment rooms, or similar areas having a collection of electrical equipment. Pipes shall not be installed over, around, in front of, in back of, or directly below, electrical controls, panels, switches, terminals, boxes, or similar electrical equipment.

5. All piping shall be installed with not less than 2 inches between finish covering of pipe and all other work or piping.

6. All piping shall have shut-off valves at all branch connections to mains.

7. Reduction in sizes of pipes shall be made with reducing fittings. Bushings will not be permitted.

8. The Contractor shall perform excavation of the subgrade where required for the installation of the work, including that for piping and piping enclosures. The backfill shall be stabilized by hand or pneumatic tamping as directed by the Professional and shall be returned to the original subgrade level. Piping shall not be run in cinder fill unless protected by a concrete envelope of 2 inches minimum thickness on all sides of pipe. All steel and copper piping and fittings installed underground shall be protected with two layers of tightly applied spirally wrapped tape, 3M number 50, or accepted substitute.

9. Bullhead connections in any piping service are prohibited.

10. All screwed joints shall be made with a non-corrosive, non-hardening compound or teflon tape applied on the male thread only. All compounds must be approved for the pipe on which they are used. Pipe ends shall be reamed or filed out to size of bore and all chips and cuttings removed. Ends of pipe must be cut square so as to seat in the bottom of the recess in drainage fittings. In making joints in chromium plated brass pipe no more than one thread shall remain exposed when joint is completed. Caulking of screwed joints is not permitted. Pipe joint cement and paint will be permitted only on external threads.

11. All soldered joints shall be made with fittings specified. Copper tube and brass pipe, valves, unions, flanges, fittings, and connections shall be joined by means of leadfree solder. Ends of

all pipe and inside surfaces of fittings shall be cleaned, burnished and tinned before solder is applied. All joints in tubing 2 inches and larger shall be tinned and then soldered with a circular type flame torch. Pull joints, saddle type joints, and "T-Drill" type connections are prohibited.

B. Drainage Piping

1. All sewer piping shall be set true to line and even slope using grade boards and targets or grade lines in accordance with ASTM C12, "Recommended Practice for Laying Sewer Pipe". Horizontal sanitary and storm piping shall be installed to pitch towards drain points. Minimum pitch shall be 1/8 inch per foot for piping 4 inch and larger. Pitch for smaller piping shall be 1/4 inch per foot minimum. Minimum pipe size below grade shall be 2 inch. To join screwed pipe to cast iron pipe, provide ring on screwed pipe to form spigot end.

2. All changes in pipe size of soil, waste, and drain lines shall be made with reducing fittings or reducers. Changes in direction, where space permits, shall be made with long sweep bends, Y-fittings, and one-eighth (1/8) or one-sixteenth (1/16) bends, or combination "Y" and 1/8 bends.

3. Cleanouts shall be furnished installed on horizontal runs and at the base of stacks for all soil, waste, drain, and rain conductor lines. A cleanout shall be installed at every change of direction of greater than 45 degrees. Cleanouts shall be installed not more than 50 feet apart for piping 4 inch size and smaller. Cleanouts shall be installed no more than 100 feet apart for piping larger that 4 inch. Cleanouts on horizontal runs above ground, including crawl spaces, shall be cast brass plugs in wye fittings. Cleanouts at the base of each vertical stack shall be cast brass plugs in wye fittings. Cleanouts on buried or concealed lines shall be brought flush with grade or floor level. Cleanouts in walls shall be brought flush with finished face of the wall. Cleanouts on underground lines shall be made with wye and 45 degree fittings. Terminal cleanouts on underground lines shall have a concrete cradle bearing block set against undisturbed earth. 45 degree fittings shall be set against concrete cradle to prevent separation or misalignment of joints. Cleanout plugs shall be full size for pipe up to and including 4 inch diameter and not less than 4 inch diameter for larger size pipe.

4. Water closet floor flanges shall be cast iron, screwed or caulked, not less than 1/4 inch thick; not less than 2 inches caulking depth. Bolted with approved gasket between closet bowl and flange. Closet screws shall be of brass. The use of commercial putty or plaster for setting closet bowls is prohibited.

C. Pressure Piping

1. Branch piping shall be as indicated but shall be a minimum 3/4 inch in nominal size with the last ten feet to each 1/2 inch outlet fixture a minimum of 1/2 inch in nominal size.

2. Each water piping system within the building shall be properly arranged and graded to low points where the entire system can be emptied through a drain.

3. Drain Valves - Furnish and install a 1/2" rough brass hose bibb with female hose connection at all low points of the domestic water piping systems. The hose bibb shall be located so as to be accessible and easily operable, and so that a hose can be connected to the outlet.

4. Outside water piping shall be so graded and arranged that water can be drained from the underground piping through drains installed in the building served. The drains shall be the same size and type specified for interior piping.

D. Equipment Piping

1. Provide shutoff valves in supply and return to each item of equipment such as pumps, tanks, automatic valves, and similar items. Valves shall be suitably located to isolate each unit to facilitate maintenance or removal of all equipment and apparatus. Valves shall be flanged or have a union installed between valve and equipment.

2. Provide all piping from backflow preventers, pump glands, relief valves, mud drains, or other drainage to spill over open sight drains, floor drains, or other trapped acceptable discharge points, and terminate with plain end (unthreaded) pipe.

3. Provide thermometer wells and pressure gauge wells for specified thermometers and gauges, and at the inlet and outlet connection of each piece of equipment specified in this contract.

E. Fuel Gas Piping

1. Horizontal fuel gas piping shall slope up in direction of flow not less than 1/4 inch in 15 feet.

2. Provide 6 inch drip leg and cap and shutoff valve at each piece of gas fired equipment, at the ends of horizontal runs and at the base or risers.

3. All fuel gas piping shall be installed in accessible locations. Piping located in or below concrete slabs shall be run in channels in the floor with suitable access panels. Where approved by the local gas utility, gas piping may be embedded in the floor slab. Such piping shall be surrounded by not less than 1-1/2 inches of Portland cement, and piping shall not be permitted to be in physical contact with any other metallic materials.

4. Where gas piping must be run in concealed spaces, all valves and joints must be accessible or, if necessary, run piping in secondary containment conduit, with valve access boxes.

5. Gas tubing run inside hollow walls or partitions shall be protected with a steel striker barrier at least .0508 inches thick. Striker barriers shall extend 4 inches beyond concealed penetrations or plates, fire stops, etc. Rigidly securing tubing run vertically inside hollow walls or partitions shall be prohibited.

6. Where gas piping is installed inside of vertical chases, welded joints shall be used. The chase shall be vented at the top and the vent run to the outside, in accordance with NFPA 54 requirements. The minimum vent pipe size shall be 1-1/4 inch. Vent piping may be steel, cast iron or copper. The Contractor shall determine the routing of this pipe and coordinate with all other trades.

7. Polyethylene fuel gas piping shall be installed in accordance with standards and specifications of the gas company and the piping manufacturer. Fusion of mechanical joints must be installed by workmen qualified in accordance with D.O.T./MTB/49CFR Part 192.

8. Use of polyethylene fuel gas piping is prohibited above ground and under floor slabs. Transition from polyethylene to steel pipe shall be made underground and piping brought above ground before entering the building.

3.3 INSULATION

A. Pipe Insulation

1. Piping to be insulated shall include all domestic water piping.

2. All insulation shall be applied in a workmanlike manner by skilled workmen regularly engaged in this type of work. Insulation shall be applied to clean and dry surfaces after tests and approvals required by this specification have been completed.

3. On cold surfaces where a vapor barrier must be maintained, insulation shall be applied with a continuous, unbroken moisture and vapor seal. All hangers, supports, anchors, or other projections that are secured to cold surfaces shall be insulated and vapor sealed to prevent condensation.

4. All surface finishes shall be extended in such a manner as to protect all raw edges, ends and surfaces of insulation.

5. All pipe insulation shall be continuous through walls, ceiling, floor openings, or sleeves; except where firestop or firesafing materials are required.

6. Metal shields shall be installed between hangers or supports and the piping insulation. Rigid insulation inserts shall be installed as required between the pipe and the insulation shields. Inserts shall be of equal thickness to the adjacent insulation and shall be vapor sealed.

B. Insulation thicknesses shall conform to the PIPING INSULATION THICKNESS TABLE.

PIPING INSULATION THICKNESS TABLE

SERVICE	PIPE SIZE	INSULATION THICKNESS
Domestic Cold Water	1/2" to 2"	1/2"
Domestic Cold Water	Larger than 2"	1"
Domestic Hot Water	1/2" to 1-1/4"	1/2"
Domestic Hot Water	1-1/2" to 2"	1"
Domestic Hot Water	Larger than 2"	1-1/2"

C. Application

1. Piping - All ends shall be firmly butted and secured with ASJ OR SSL butt strips of a minimum 3 inches wide. ASJ jacket laps and butt strips shall be secured by use of a suitable lap adhesive. Exposed end of pipe insulation shall be sealed with vapor retardant mastic at all fittings and valves.

2. Fitting and Valves - All fittings and valves shall be insulated with preformed fiber glass fittings, mitered sections of pipe insulation or fiber glass blanket. Insulation shall be of equal thickness to the adjacent pipe insulation.

3. Fitting and valves shall be further finished by applying PVC Fitting Covers. PVC covers shall be secured using solvent type PVC adhesive. All circumferential edges shall be further sealed by an overlap of at least 2 inches onto adjacent pipe insulation using PVC tape or ASJ/SSL butt strip material.

3.4 SLEEVES AND FLOOR PLATES

A. Sleeves shall be provided for all pipes passing through walls, partitions, floor slabs or roof slabs. Sleeves shall be cut flush with wall, floor or ceiling surfaces except that sleeves through

waterproofed roof or floor slabs shall extend one inch (1") above the finished surface. Sleeves shall be sufficient size to allow a sealable annular space between the sleeve and the pipe or between the sleeve and the pipe insulation. All exposed piping passing through floors, walls or ceiling shall be provided with a chrome escutcheon plate securely fastened around the pipe. The annular space around the pipe in non-water-proof sleeves shall be filled with penetration sealant and smoothed out flush with all surface.

B. All pipe, tube, conduit, or similar through-penetrations of all fire rated walls, floor-ceiling, or roof-ceiling assemblies shall be provided with a fire stopping system to achieve a tight seal that will maintain the fire resistant rating of the assembly containing the through-penetration. Fire stopping system may be sealant or mechanical type.

3.5 PROTECTION AGAINST PHYSICAL DAMAGE

A. In concealed locations, where piping, other that cast-iron or galvanized steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1¼-inches from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 1/16-inch thick steel, shall cover the area of the pipe where the member is notched or bored and shall extend a minimum of 2-inches above sole plates and below top plates.

B. Fuel gas piping shall be protected in accordance with NFPA 54.

3.6 SUPPORTS, HANGERS, INSERTS AND FASTENERS

A. The Contractor shall furnish and install all supports, hangers, inserts and fasteners for the items incidental to the work in the construction of the project. Supports and hangers shall be provided to suit specific conditions for the type of construction. The method adopted shall be subject to the approval of the Professional.

B. Supports shall secure pipes in place, prevent swaying and vibration, maintain required grading, provide free expansion and shall have a neat appearance. Supports shall be selected for strength and service and installed in a manner which will not stress building construction. Supports shall be selected for safety factor of five (5) to one (1) for gross weight of piping system including fluid and installation.

C. Where support is from concrete construction, take care not to weaken concrete or penetrate waterproofing. Only use inserts for suspending hangers from concrete slabs. Use beam clamps for suspending hangers from building steel. Do not hang one pipe from another. Do not use perforated band iron, wire or chain as hangers. Do not use vertical expansion shields. Do not hang from joist bridging.

D. Fastenings required in masonry walls; bolts shall be galvanized U-bolts set in the construction during erection.

E. Where several pipes can be installed in parallel at the same elevation, provide trapeze hangers. Trapeze hangers shall be suspended by means of rods or angles. Brace trapeze hangers to prevent motion due to expansion and contraction of pipe. Support individual pipes by hangers or rollers.

F. All vertical piping shall be supported at each floor level. Riser clamps at exposed locations shall be of such design as to avoid creating a hazardous or unsightly condition and stay within space limitations. Pipe supports are required at the base of all vertical risers and shall be of riser size. In

the case of waste and vent risers for plumbing system, support the fitting at the base of the riser independently from the adjacent pipe joint support.

G. Where hanger rods are longer than 18 inches, provide lateral bracing at every fourth hanger. Do not support piping by wire, rope wood or other makeshift device. Provide additional steel supports where building construction does not permit the hanger spacing as specified in the schedules. Location and details shall be submitted to the Professional for review.

H. Roller type supports shall be used for pipes subject to axial movement. Brace so movement occurs in roller rather than support rod.

I. Where loading exceeds the safe allowable limit for any single insert, then multiple inserts shall be installed spaced no less than 12 inches on centers. The multiple inserts shall be connected with suitable size steel angles and locking bolts.

J. Where inserts in new construction have been omitted or are required in existing construction, the fastening shall be accomplished by means of approved lead sheathed expansion bolts. Wood plugs shall not be used. Expansion shields in precast concrete slabs shall not be loaded more than one-half (1/2) their maximum design capacity and never more than 200 pounds per bolt. Where bolts used with lead expansion bolts are spaced closer than one-foot centers, the multiple bolts shall be connected with suitable size steel angles and locking bolts or with single bolts extending through the slab above with a bearing plate. Where finished floors occur, the welded plate and rod shall be recessed in the slab, finished in an approved manner.

K. Where fastenings are required in steel stud, wire lath or other non-masonry construction, a "J" hook and holding lock washer and nut shall be used which shall fasten to the opposite stud edge to which the item will abut. If the location of the fastening is not a steel stud, a structural steel shape shall be fastened to the wall with bolt and holding nut, with the fastening extension through the wall. The use of toggle bolts will not be permitted.

L. Steel frame Construction

1. Where roofing construction is supported by structural steel members or bar joist, support piping systems, devices, and equipment from structural steel members or secondary fabricated supports. No hanging from corrugated metal deck shall be allowed.

2. Where concrete floor construction is supported by structural steel members or bar joist, support of piping, ductwork, devices and equipment may be from metal tabs integral with the metal deck system to the maximum of the equivalent of a 10 foot length of 4 inch Schedule 40 section of pipe filled with water or 6 inch cast iron drainage pipe. Where tabs projecting down from the metal deck system are not available, inserts for concrete deck construction shall be installed. Inserts in poured concrete slabs shall be iron, fabricated galvanized iron or steel of the type to receive a machine bolt head or nut after installation and shall permit adjustment of this bolt in one horizontal direction.

M. Reinforced Concrete Construction

1. Where poured concrete roof and floor construction is supported by concrete members, support piping systems, devices, and equipment from roof to floor construction by use of concrete slab inserts.

2. Inserts in poured concrete slabs shall be iron or fabricated galvanized iron or steel of the type to receive a machine bolt head or nut after installation and shall permit adjustment of this bolt in one (1) horizontal direction. Inserts shall be accurately located before the concrete is poured.

3. Piping, tanks and equipment shall be adequately supported either by suspension from the construction above or by means of struts or brackets to the construction below or to the side.

4. Before drilling any concrete for attachments, installer shall carefully check concrete drawings and shop drawings and shall locate drilled holes to avoid reinforcing by at least 1 inch.

N. HANGER AND ROD SCHEDULE

NOMINAL DIAMETER	STEEL PIPE		COPPER TUBING	
PIPE OR TUBE SIZE INCHES	SPACING FEET	ROD SIZE INCHES	SPACING FEET	ROD SIZE INCHES
1/2	5	3/8	5	3/8
3/4	6	3/8	6	3/8
1	7	3/8	6	3/8
1-1/4	8	3/8	7	3/8
1-1/2	10	3/8	8	3/8
2	10	3/8	9	3/8
2-1/2, 3	10	1/2	10	1/2
4,5	10	5/8	12	5/8
6	10	3/4	12	7/8
8, 10, 12	10	7/8	12	7/8

Where unusual concentrated loads of valves and fittings occur, closer spacing shall be required. Submit specific cases for review and comment.
Where piping changes direction, supports shall be placed in each direction adjacent to joints and no more than 12 inches from the joint.
Piping larger than 16 inches shall be supported according to the details on the drawings.

3.7 EXPANSION COMPENSATORS AND GUIDES

A. Expansion compensators shall be provided where shown on the drawings and in all other locations where necessary to compensate for piping expansion and to prevent damage to building, equipment and piping. Expansion compensators shall be used with anchors and guides. Install expansion

compensators in compressed or extended position as required to achieve 2 inch maximum deflection.

B. Pipe guides shall be installed on the free side of all expansion compensators and as necessary to prevent piping from bowing, etc. All guides and anchors shall be sized to handle the loads imposed and shall be securely fastened to the structure or to supplemental steel framing.

C. Pipe anchors shall be installed on the fixed side of all expansion compensators and wherever shown on the drawings.

3.8 VALVES

A. Valves shall be installed at each riser, branch to equipment, at each group of fixtures, at each fixture not equipped with stop valves, and where shown on the drawings. Valves shall be installed with stems at or above the horizontal plane.

B. Where supplies to individual fixtures occur in base cabinets, or in other places where copper tubing supplies are used stops shall be solder end

3.9 CATHODIC PROTECTION OF UNDERGROUND FUEL GAS PIPE

A. All non-plastic underground fuel gas piping shall be cathodically protected. Provide a minimum of seventeen pound magnesium anodes containing six percent (6%) aluminum and three percent (3%) zinc alloy. Anodes shall be distributed equally along the pipe run, but spacing shall not exceed 100 feet between anodes. Each anode shall be attached to the pipe by the Caldwell and brazing process. The connecting wire shall be #12 A.W.G. copper with TW insulation. Each anode shall be repacked and shall be buried in backfill composed of seventy-five percent (75%) gypsum, twenty percent (20%) bentonite and five percent (5%) sodium sulphate. Wherever the underground gas piping rises above grade, provide an insulating dielectric fitting.

B. Utility Marking Tape

1. Install detectable utility marking tape above all outside pipelines, 12 inches to 18 inches below grade.

END OF SECTION

SECTION 221310

PLUMBING SPECIALTIES

Part 1 GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SECTION INCLUDES

A. Work in this Section includes the following:

1. Cleanouts
2. Floor Drains
3. Trench Drains
4. Hose Bibbs
5. Freeze Proof Hose Bibb
6. Backflow Preventors
7. Water Hammer Arrestors
8. Trap-Seal Primer Device
9. Water Meters
10. Gas Pressure Regulators

Part 2 PRODUCTS

2.1 CLEANOUTS

A. Cleanouts shall be of coated cast iron construction with scoriated nickle bronze tops, (unless noted), vandalproof screws. Floor cleanouts shall be adjustable to finished floor after concrete is set. Cleanouts on exposed piping shall consist of threaded ferrules with threaded bronze plugs. Cleanouts shall be as manufactured by Jones Spec, Josam, J.R. Smith, Wade or Zurn.

B. Cleanout types shall be as follows:

1. Finished Floor Cleanouts

Josam J.R. Smith Wade	W -6000-5

Zurn ZN-1400-2

2. Wall Cleanouts

Josam
Smith
Wade
Zurn ZANB-1468

2.2 FLOOR DRAINS

FD-1 Dura-coated cast-iron light duty floor drain with Type "B" 5-inch round nickel-bronze strainer, adjustable to finished floor. Floor drain shall be ZN-415-5B-P as manufactured by Zurn Industries, Inc. Wade 1100-TY-STDS-1

2.3 TRENCH DRAINS

a. Trench Drains TD-1:

(1). Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

(a). Zurn Plumbing Products Group; Specification Drainage Operation
(b). Josam Company; Josam Div.
(c). Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
(d). Tyler Pipe; Wade Div.

(2). Standard: ASME A112.6.3 for trench drains.
(3). Material: Ductile or gray iron.
(4). Flange: Anchor
(5). Clamping Device: Required.
(6). Outlet: Bottom
(7). Grate Material: Ductile iron
(8). Grate Finish: Not required.
(9). Top Loading Classification: Heavy Duty.

2.4 HOSE BIBBS

A. HB-1 Hose Bibb

1. Angle pattern hose bibb consisting of a brass body, vacuum breaker-backflow preventor with 3/4-inch male hose thread nozzle, tee-handle and 3/4-inch copper water tube inlet. Hose bibb shall be Model 24C as manufactured by Woodford Manufacturing Co.

2.5 BACKFLOW PREVENTORS

A. Backflow preventors shall be installed where shown on the drawings and conform to the type required by the local water authority.

B. Units shall be supported in accordance with manufacturer's recommendations.

C. Acceptable Manufacturers: Watts, FEBCO, Wilkins.

D. Reduced Pressure Backflow Preventors - ANSI/ASSE 1013; bronze body with bronze and plastic internal parts and stainless steel springs; two (2) independently operating, spring loaded check valves with replaceable seats; diaphragm type differential pressure relief valve located between check valves; non-threaded vent outlet; assembled with two (2) gate valves, strainer, and test cocks.

E. Double Check Valve Assemblies - ANSI/ASSE 1015; corrosion resistant internal parts and stainless-steel springs; two independently operating check valves, assembled with two (2) gate valves, strainer, and test cocks.

2.6 WATER HAMMER ARRESTORS

A. Water Hammer Arrestors shall be of Type "L", Type "K" copper or stainless-steel bellows or plunger type construction conforming to PDI WH-201. Sioux Chief Series 650, PPP, Inc., Series SWA or SC, JR Smith, Josam, or Zurn.

2.7 TRAP-SEAL PRIMER DEVICE,

A. Supply-Type, Trap-Seal Primer Device:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Sioux Chief Manufacturing Company, Inc.
    b. Precision Plumbing Products, Inc.
    c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished

2.8 WATER METERS

A. Water meters shall conform to AWWA C-700 and have a working pressure rating of 150 pounds per square inch gauge (psig). Meters shall be designed to measure flow in one direction only.

B. Positive displacement disc type meters up to 2-inch size shall be as manufactured by Hersey measurement Company, Sensus or accepted substitution.

C. Compound type water meters 2-inch size and larger shall have integral test plug for incline testing as manufactured by Sensus or accepted substitute.

2.9 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psig minimum working pressure, unless otherwise indicated.

1. Hose: Reinforced double-wire-braid, CR-covered hose for compressed-air service.

2. Hose Clamps: Stainless-steel clamps or bands.

3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.

4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

2.10 GAS PRESSURE REGULATORS

A. Gas pressure regulators shall be diaphragm actuated with cast iron body, aluminum diaphragm chamber, and all internal parts designed for use with natural gas. Regulators shall be adjustable, with automatic loading, automatic low-pressure cut-off, and full internal relief. The regulator shall be adjusted for outlet pressure indicated on the drawings. The outlet pressure shall not vary more than 1-inch w.c. from the set point at specified capacity. The regulator shall be capable of complete shut-off in the event the supply pressure is interrupted, or the gas demand exceeds the regulator capacity and shall remain off until the regulator is manually reset. The regulator shall have a weatherproof, bug proof, screened vent cap installed in the vent tapping. Regulators shall be:

Regular	3/4" - 1-1/4"	1-1/2" - 2"
Rockwell	143-4	243-12-4
Fisher	1823B	--------
Singer	S-104	S-204
With Full Relief	3/4" - 1-1/4"	1-1/2" - 2"
Rockwell	143-6	143-12-6
Fisher	1883B	--------
Singer	S-106	S-206

Part 3 EXECUTION

3.1 INSTALLATION

A. All materials, equipment and accessories shall be installed in strict accordance with manufacturer's recommendations.

B. Provide isolation valves for all fixtures, equipment, and accessories.

C. All floor drains shall be flush with floor and per manufacturers recommendations.

END OF SECTION

SECTION 223400

PLUMBING EQUIPMENT

Part 1 GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 SECTION INCLUDES

A. Work in this Section includes the following:

1. Water Heaters

Part 2 PRODUCTS

2.1 WATER HEATERS

1. GAS-FIRED, TANKLESS, DOMESTIC-WATER HEATERS

a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

(1). Rinnai
(2). Or approved equal

b. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.

c. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.

(1). Tappings: ASME B1.20.1 pipe thread.
(2). Pressure Rating: 150 psig.
(3). Heat Exchanger: Copper tubing.
(4). Insulation: Comply with ASHRAE/IESNA 90.1.
(5). Jacket: Metal, with enameled finish.
(6). Burner: For use with tankless, domestic-water heaters and natural-gas fuel.
(7). Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
(8). Temperature Control: Adjustable thermostat.

d. Support: Bracket for wall mounting.

e. Capacity and Characteristics:

(1). Flow Rate: 3.25 gpm at 100 deg F temperature rise.
(2). Temperature Setting: 120 deg F.

(3). Maximum Fuel Gas Input: 199,900 Btu/h.
(4). Electrical Characteristics:

(a). Volts: 120.
(b). Phase: Single.
(c). Hertz: 60.
(d). Full-Load Amperes: 2.
(e). Maximum Overcurrent Protection: 15.

(5). Vent Diameter: 3 inches.
(6). Combustion Air Diameter: 3 inches.

2.2 EXPANSION TANK

A. Pre-pressurized diaphragm type steel expansion tank. Tank shall conform to ASME Section VIII construction for 125 psig, (200 psig WOG), tank shall have rigid polypropylene lining for corrosion control, butyl rubber diaphragm. Provide pressure gage on system connection piping. (When system water pressure exceeds 80 psig provide a pressure regulating valve on the cold water supply to the water heater.)

B. Thermal expansion tank shall be installed to absorb expansion from hot water generator and storage tanks under no-flow or low-flow conditions. System connection shall be not located upstream of check valves or regulating valves or downstream of mixing valves or in a manner that shall negate this purpose.

C. Thermal expansion tank pressurization shall be field charged to match the domestic water system pressure when pumps are energized but when water temperature in storage tank is at 40 to 80°F temperature. Acceptance volume shall be based upon the difference between system pressure and temperature relief valve pressure).

1. Amtrol, Inc.

2. Bell & Gossett

3. Thrush

4. Wellels Company

STORAGE TANK SIZE	EXPANSION TANK MODEL
Up to 250 gallon	ST-30V

Part 3 EXECUTION

3.1 INSTALLATION

A. All equipment, piping and accessories shall be installed in strict accordance with manufacturer's requirements.

B. Piping shall be all of the same material, mixed copper, steel installations are prohibited.

C. Provide isolation valves for all equipment, and accessories.

D. Unions shall be provided adjacent to all equipment or wherever necessary to facilitate the removal of equipment for repair of replacement. Unions for copper tubing up to and including 2" diameter shall be brass ground joint with socket ends for solder. Unions for copper tubing 2-1/2" in diameter and over shall be standard brass flanges with socket ends for solder. Flanges to be drilled for ASA Standard 125 lbs. flanges and so stamped. No lip type unions or long screws will be permitted. The Contractor shall furnish and install all structural steel angles, channels, etc. necessary to properly support all fixtures and equipment to the satisfaction of the Professional.

E. Furnish and install isolation valves at the cold water and hot water supply tappings and an AGA/ASME pressure and temperature relief valve for each water heater.

END OF SECTION

SECTION 230500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Dielectric fittings.
3. Sleeves.
4. Escutcheons.
5. Equipment installation requirements common to equipment sections.
6. Painting and finishing.
7. Supports and anchorages.
8. Cast-in-Place Concrete.

1.4 DEFINITIONS

A. Provide: The term "provide", as used in these specifications and on the drawings, shall be understood to mean "the Contractor shall furnish and install, complete and operational, with all required hardware, accessories and appurtenances."

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

C. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

D. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

F. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

G. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

2. PVC: Polyvinyl chloride plastic.

H. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

A. Product Data: For the following if utilized:

1. Transition fittings.

2. Dielectric fittings.

B. Steel Certifications.

1.6 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.8 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

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 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

1. Manufacturers:
   a. Eclipse, Inc.
   b. Epco Sales, Inc.
   c. Hart Industries, International, Inc.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Industries, Inc.; Wilkins Div.
   f. Or approved equal.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.

1. Manufacturers:
   a. Capitol Manufacturing Co.
   b. Epco Sales, Inc.
   c. Watts Industries, Inc.; Water Products Div.
   d. Or approved equal.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Pipeline Seal and Insulator, Inc.
   d. Or approved equal.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Calpico, Inc.
   b. Lochinvar Corp.
   c. Or approved equal.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:
   a. Perfection Corp.
   b. Precision Plumbing Products, Inc.
   c. Victaulic Co. of America.
   d. Or approved equal.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

D. PVC Pipe: ASTM D 1785, Schedule 40.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Rough brass.

D. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.8 CAST-IN-PLACE CONCRETE

A. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301, as follows:

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
4. Slump Limit: 4 inches, plus or minus 1 inch.
5. Air Content: Maintain within range permitted by ACI 301 (ACI 301M). Do not allow air content of trowel-finished floor slabs to exceed 3 percent.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. 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.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. 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.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
   c. Bare Piping in Equipment Rooms: One-piece, cast-brass type.

M. Sleeves are not required for core-drilled holes.

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.
   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

O. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Verify final equipment locations for roughing-in.

P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not 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 HVAC 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.

3.5 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

B. Field Welding: Comply with AWS D1.1.

3.7 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.8 CONCRETE PLACEMENT

A. Comply with ACI 301 for placing concrete.

B. Do not add water to concrete during delivery, at Project site, or during placement.

C. Consolidate concrete with mechanical vibrating equipment.

END OF SECTION

SECTION 230510

HVAC ELECTRICAL EQUIPMENT AND WIRING REQUIREMENTS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 ELECTRICAL EQUIPMENT

A. General:

1. This Contractor shall furnish all motors, starters, disconnects for motors and heating coils and controls for equipment under his Contract, unless otherwise noted.

2. Electrical Contractor shall install all starters, disconnects and overload protectors furnished by this Contractor and shall provide all necessary wire, conduit and boxes to properly connect equipment for this Contractor no matter how many disconnects, starters, etc. are included, unless otherwise noted.

3. This Contractor shall provide all necessary conduit and control wiring to pushbuttons, thermostats, pilot lights, interlocks and similar equipment for this Contractors equipment.

4. Flow control switches, thermostats and similar mechanical-electrical devices necessary for proper operation of mechanical systems shall be furnished and installed by this Contractor.

5. Where the starter and/or safety switch is an integral part of the equipment assembly, the assembly shall be furnished with the wiring complete between starter, controller and motor. The Electrical Contractor will make connections to unit terminals.

6. If motor control center is furnished (and installed) by Electrical Contractor for specific motors, the Mechanical Contractor shall not furnish starters for those specific motors, however the Mechanical Contractor shall furnish Electrical Contractor with starter requirements to insure proper operation of those motors.

7. All motors and motor control equipment and wiring shall meet the requirements of the NEC and shall comply with the requirements of the Public Utility Company furnishing service and with the rules and regulations of all authorities having jurisdiction.

8. Voltage available at the building is 120/208 volts and 277/480 volts - three phase - four wire (latter preferred).

9. THIS CONTRACTOR SHALL VERIFY VOLTAGE AT SITE BEFORE ORDERING ANY ELECTRICAL EQUIPMENT.

10. The Electrical Contractor shall be responsible for proper rotation of three phase equipment.

PART 2 - PRODUCTS

2.1 POWER FACTOR CORRECTION

A. This Contractor shall be responsible for all equipment, labor, coordination and other related appurtenances required for the installation of power factor correction devices at all equipment supplied under his contract. Heating, Ventilating and Air Conditioning equipment requiring power factor correction devices shall be furnished and installed with the same as hereinafter specified. Power factor correction devices (including means and methods) shall be included as part of their respective equipment submittal, materials, wiring, diagrams, shop drawings, and catalog cuts for review by the Professional.

B. Devices shall be furnished and installed to ensure a minimum power factor of 90% over the full operating range of the equipment. Equipment requiring power factor correction devices are:

1. All Makeup Air Units
2. Condensing Units
3. All three-phase mechanical exhausters & fans of any type.
4. Pumps
5. ATC

2.2 CONTROL WIRING

A. All wiring and conduit shall be according to the latest edition of the NEC. All control wiring shall be installed in EMT, applicable portions of the NEC and of "DIVISION 16 - ELECTRICAL".

B. Low voltage control wiring in air plenums shall be a UL approved conductor for application as manufactured by Alpha or Beldon or approved equal.

2.3 STARTERS/DISCONNECTS

A. Starters shall be combination disconnect type.

B. Combination motor starters shall be of the fused switch type complete with magnetic motor starter. Unit shall be of the NEMA Class and size as applicable to motor size, with 3-pole

overload. Overload elements and fuses shall be of the proper size to protect the motor. Unless otherwise noted, units shall be equipped with indicating lights, HAND-OFF-AUTOMATIC selector switch, four (4) auxiliary contacts (two N.O. and two N.C.) and fused control transformer to provide 24-volt control voltage.

C. Fusible disconnect switch operating handles shall be interlocked with the door so that the door cannot be opened with the switch in the ON position, except through a hidden release mechanism. The operating handle shall be arranged for padlocking in the OFF position with up to three padlocks. Fuses shall be furnished by this contractor, of size required to comply with NEC. Where R type fuses are indicated, fuse holders shall be provided with rejection clips.

D. The control circuit shall be wired for 24-volt control, using fused individual control transformers. Circuit shall be fused and shall be interrupted when disconnect device is opened.

E. Combination Motor Starter Manufacturer: Except where an item of mechanical equipment must be integrally furnished with a motor starter produced by another manufacturer, provide combination starters for mechanical equipment manufactured by a single one of the following:

1. Allen-Bradley Co.
2. Cutler-Hammer, Inc.
3. General Electric Co.
4. Square D Co.
5. Or approved equal.

F. All starters shall automatically restart if there is a power outage.

G. Reduced voltage starters shall be provided to comply with power company limitations on in rush current. Refer to electrical drawings or power company for limitations. When reduced voltage starters are to be provided, this information must be given to Electrical Contractor and he must include the cost of connecting these starters in his bid.

H. Units shall have NEMA type 1 enclosure (unless noted otherwise) and as required to comply with NEC.

PART 3 - EXECUTION

3.1 CONTROL WIRING

A. Workmanship on all phases of control wiring shall be equal to that of the Electrical Contractor and shall be performed by competent workmen.

B. Horizontal cable runs shall be made level. Vertical cable runs shall be made plumb. Exposed cable runs shall run parallel or perpendicular to walls and ceilings, i.e., no unsightly diagonals or bends.

C. In building equipment spaces, cables may be run along and strapped to the surface of walls using mechanical fasteners with wire ties.

D. Horizontal cable runs shall be supported every 12 inches, and vertical cable runs shall be supported every 24 inches. Cables will be run in a workmanlike manner parallel to the floor with all droops removed by pulling taut but without exceeding the tensile strength of the conductors.

E. Cable runs may not be run along or fastened to: any telephone cable superstructure, including those supported from the ceiling, from the wall, or on top of the telephone equipment frames; any air handling ductwork beyond fifteen feet from the supply or return fan; any fluid or gas piping.

F. Cables shall be concealed unless permission is otherwise solicited from the Professional and granted in writing.

3.2 RESPONSIBILITIES

A. The following is a list of equipment provided by this Contractor and shows both this Contractor's and the Electrical Contractor's responsibility for the furnishing, installing and connection of control, disconnecting and overload equipment.

B. The conditions under Electrical Equipment, General (above) also apply to these paragraphs.

C. Provide to the Electrical Contractor shop drawings, product data, and manufacturer's instructions for equipment furnished under DIVISION 23.

1. Wall Mounted Unit Heaters
   a. 120-volt, 1 phase.
   b. Thermal overload switch provided by Electrical Contractor adjacent to the unit.
   c. Integral thermostat.
   d. Control transformers shall be provided by this Contractor.
2. Radiant Panel Heaters
   a. 120-volt, 1 phase.
   b. Thermal overload switch provided by Electrical Contractor adjacent to the unit.
   c. Control transformers shall be provided by this Contractor.
3. Unit Heaters
   a. 120-volt, 1 phase.
   b. Thermal overload switch provided by Electrical Contractor adjacent to the unit.
   c. Control transformers shall be provided by this Contractor.
4. Restroom Exhaust Fans – ATC Controlled
   a. 120 volt, 1 phase.
   b. Combination starter/disconnect switch furnished by this Contractor and installed by the Electrical Contractor.
   c. Control transformer shall be provided and wired by this Contractor.
5. Exhaust Fans
   a. 120 volt, 1 phase.

b. Combination starter/disconnect switch furnished by this Contractor and installed by the Electrical Contractor.
c. Control transformer shall be provided and wired by this Contractor.

6. Vehicle Exhaust Fans
   a. 120 volt, 1 phase and 208 volt, 3 phase
   b. Combination starter/disconnect switch furnished by this Contractor and installed by the Electrical Contractor.
   c. Control transformer shall be provided and wired by this Contractor.

7. Make up air unit
   a. 208 volt, 3 phase
   b. Combination starter/disconnect switch furnished by this Contractor and installed by the Electrical Contractor.
   c. Control transformer shall be provided and wired by this Contractor.

8. Indoor Fan Coil Units
   a. 208 volt, - 1 phase.
   b. All wiring from the input terminals to the respective devices in the unit shall be factory installed by the equipment manufacturer.
   c. Remote combination starter/disconnect switch shall be furnished by this Contractor and installed by the Electrical Contractor.
   d. Control transformers shall be provided and wired by this Contractor.

9. Heat Pump Unit (Outdoor)
   a. 208 volt, - 1 phase.
   b. Starters with overload protection shall be furnished and installed by equipment manufacturer.
   c. The Electrical Contractor shall furnish and install a fused weatherproof disconnect switch.
   d. All wiring to the respective devices in the unit shall be factory installed by the equipment manufacturer.
   e. Control transformers with weatherproof enclosure shall be provided and wired by this Contractor.

END OF SECTION

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fastener systems.
4. Equipment supports.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.

2. Equipment supports.
3. Steel Certification.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated, stainless- steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.4 EQUIPMENT SUPPORTS

A. Description: Shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.5 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Non-staining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported.

B. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

D. Install lateral bracing with pipe hangers and supports to prevent swaying.

E. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

F. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.

4. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
5. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

8. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
9. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

K. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

END OF SECTION

SECTION 230548

VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Spring hangers.
3. Spring hangers with vertical-limit stops.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

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. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.

6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel base-plates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant neoprene.

C. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

D. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.2 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
3. Baked enamel or powder coat for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Strength of Support: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits.

3.3 VIBRATION-CONTROL DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

E. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

G. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or

drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ADJUSTING

A. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

B. Adjust active height of spring isolators.

C. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.5 HVAC VIBRATION-CONTROL DEVICE SCHEDULE

A. Supported Equipment:

1. Equipment Location: Exterior.
2. Pads:

    a. Material: Neoprene.
    b. Thickness: 0.125inches.
    c. Number of Pads: One thick.

B. Suspended Equipment:

1. Isolator Type: Spring Hangers with Vertical-Limit Stop.
2. Minimum Deflection: 0.25inches.

END OF SECTION

SECTION 230553

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following mechanical identification materials and their installation:

1. Equipment nameplates.
2. Equipment markers.
3. Pipe labels.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

1.5 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES

A. Equipment Nameplates: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

1. Terminology: Match schedules as closely as possible.
2. Data: Equipment Number.
3. Size: 1 x 4 inches for equipment.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semi rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:
1. Air Handler, Heat Pump, Exhaust Fan, Make-Up Air and Energy Recovery Ventilator equipment.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches
2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
3. Locate markers where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet 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 labels.

B. Pipe Label Color Schedule:

1. Condensate-waste Water Piping:

   a. Background Color: Blue.
   b. Letter Color: White.

2. Heating Water Piping:

   a. Background Color: Red.
   b. Letter Color: White.

3. Refrigerant Piping:

   a. Background Color: Green.
   b. Letter Color: White.

3.4 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

END OF SECTION

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.
b. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

a. Constant-flow hydronic systems.
b. Variable-flow hydronic systems.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

F. TDH: Total dynamic head.

1.3 ACTION SUBMITTALS

A. TAB Report: Documentation indicating that Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.4 INFORMATIONAL SUBMITTALS

A. Strategies and Procedures Plan: Within **60** days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

B. Certified TAB reports.

1.5 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. TAB Specialists Qualifications: Certified by **NEBB**.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by **NEBB**.
2. TAB Technician: Employee of the TAB specialist and certified by **NEBB** as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures for balancing the systems.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Duct systems are complete with terminals installed.
b. Fans are operating, free of vibration, and rotating in correct direction.
c. Automatic temperature-control systems are operational.

d. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete, and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

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

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in **inch-pound (IP)** units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from **Owner** for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gage heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

    b. Measure pump TDH as follows:

        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gage heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

    c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:

    a. Measure differential pressure and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:

    a. Measure and balance coils by either coil pressure drop or temperature method.
    b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:

    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gage heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

a. Measure differential pressure, and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-

frequency controller to control system differential-pressure set point. Record pump data under both conditions.

11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:

    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.

13. Verify that memory stops have been set.

3.9 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Apparatus-Coil Test Reports:

1. Coil Data:

    a. System identification.
    b. Location.
    c. Coil type.
    d. Number of rows.
    e. Fin spacing in fins per inch o.c.
    f. Make and model number.
    g. Face area in sq. ft.
    h. Tube size in NPS.
    i. Tube and fin materials.
    j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm.
    b. Average face velocity in fpm.
    c. Air pressure drop in inches wg.
    d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
    e. Return-air, wet- and dry-bulb temperatures in deg F.
    f. Entering-air, wet- and dry-bulb temperatures in deg F.
    g. Leaving-air, wet- and dry-bulb temperatures in deg F.
    h. Water flow rate in gpm.

i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

F. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches (mm), and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).

H. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary airflow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final airflow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).

I. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

    a. System and air-handling-unit identification.
    b. Location and zone.
    c. Room or riser served.
    d. Coil make and size.
    e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm (L/s).
    b. Entering-water temperature in deg F (deg C).
    c. Leaving-water temperature in deg F (deg C).
    d. Water pressure drop in feet of head or psig (kPa).
    e. Entering-air temperature in deg F (deg C).
    f. Leaving-air temperature in deg F (deg C).

J. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Service.
    d. Make and size.
    e. Model number and serial number.
    f. Water flow rate in gpm.
    g. Water pressure differential in feet of head or psig.
    h. Required net positive suction head in feet of head or psig.
    i. Pump rpm.
    j. Impeller diameter in inches.
    k. Motor make and frame size.
    l. Motor horsepower and rpm.
    m. Voltage at each connection.
    n. Amperage for each phase.
    o. Full-load amperage and service factor.
    p. Seal type.

2. Test Data (Indicated and Actual Values):

    a. Static head in feet of head or psig.
    b. Pump shutoff pressure in feet of head or psig.
    c. Actual impeller size in inches.
    d. Full-open flow rate in gpm.
    e. Full-open pressure in feet of head or psig.
    f. Final discharge pressure in feet of head or psig.
    g. Final suction pressure in feet of head or psig.

h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

K. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.10 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of **Owner**.

B. **Owner** shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, **Owner** may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

3.11 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230719

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Refrigerant piping (liquid, gas & equalizer), indoors and outdoors.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 Schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin and wrapped with a factory applied FSK or ASJ jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

H. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Pittsburgh Corning Corporation; Foamglas.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552,Type II, Class 2.
7. Factory fabricated shapes according to ASTM C 450 and ASTM C 585.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2.2 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

2.4 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, Paintable, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.5 TAPES

A. ASJ Tape: White, Paintable, vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABI, Ideal Tape Division; 428 AWF ASJ.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    c. Compac Corporation; 104 and 105.
    d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ABI, Ideal Tape Division; 491 AWF FSK.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   c. Compac Corporation; 110 and 111.
   d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.
   e. Or approved equal.

2. Width: 3 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.6 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

   c. Or approved equal.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020-inch-thick, 1/2 inch wide with wing seal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
5. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
6. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
2. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

3. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

C. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 FINISHES ON ALL EXPOSED INTERIOR PIPE

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Government Design Professional from manufacturer's full range. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.10 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 3/4 inch thick.
b. Cellular Glass: 1-1/2 inches thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

B. Refrigerant piping (liquid, gas & equalizer):

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1 inch thick.
b. Cellular Glass: 1-1/2 inches thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant piping (liquid, gas & equalizer):

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 2 inches thick.
b. Cellular Glass: 2 inches thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

END OF SECTION

SECTION 230900

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 STIPULATION

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 01 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 DESCRIPTION

A. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers, a control system server, and a web-based operator interface.

B. System software shall be based on a server/thin-client Design Professionalure, designed around the open standards of web technology. The control system server shall be accessed using a Web browser over the control system network, the Client Agency's local area network and (at the Client Agency's discretion) over the Internet. The server shall also act as a "workstation" when running as a server/client platform. Additional clients shall have concurrent access to the "workstation" in this mode.

C. The intent of the thin-client Design Professionalure is to provide operators complete access to the control system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to download programming into the controllers.

D. System shall use BACnet protocol for communication between the control modules and web server. Communication between the web server and the user's browser shall be HTTP or HTTPS protocol utilizing HTML5. Use of Adobe Flash technology is not acceptable. I/O points, schedules, setpoints, trends, and alarms specified in the Sequence of Operations for HVAC Controls shall be BACnet objects.

1.3 APPROVED CONTROL SYSTEMS

A. The following are approved control system suppliers, manufacturers, and product lines:

1. Johnson Controls, Inc.; Controls Group.

a. Christopher J Barlow Christopher.J.Barlow@jci.com
b. Cell 717-712-1871

B. The above item has been approved by the Department as a Proprietary Item. No other item will be accepted. Article 9, Paragraph 9.6, Substitutions of Material, of the General Conditions to the Construction Contract does not apply to the above item.

1.4 ABBREVIATIONS

A. The following abbreviations are utilized within this section and the sequences of operations.

Refer to mechanical drawings for additional abbreviations.

1. AC: Air Conditioning
2. ACU: Air Conditioning Unit
3. AHU: Air Handling Unit
4. AI: Analog Input
5. AO: Analog Output
6. ATC: Automatic Temperature Control.
7. AUTO: Automatic
8. AUX: Auxiliary
9. AV: Analog Value
10. BAS: Building Automation System.
11. BI: Binary Input
12. BO: Binary Output
13. BV: Binary Value
14. C: Common
15. CFM: Cubic Feet per Minute.
16. CHW: Chilled Water
17. CHWP: Chilled Water Pump
18. CHWR: Chilled Water Return
19. CHWS: Chilled Water Supply
20. COND: Condenser
21. CV: Constant Volume
22. CW: Condenser Water
23. CWP: Condenser Water Pump
24. CWR: Condenser Water Return
25. CWS: Condenser Water Supply
26. DA: Discharge Air
27. DDC: Direct-digital controls.
28. DI: Digital Input.
29. DO: Digital Output.
30. EA: Exhaust Air
31. EF: Exhaust Fan
32. EVAP: Evaporator
33. FAS: Fire Alarm System.
34. FCU: Fan Coil Unit
35. HOA: Hand / Off / Auto
36. HP: Heat Pump
37. HRU: Heat Recovery Unit
38. HVAC: Heating, Ventilating and Air Conditioning.
39. HW Hot Water
40. HWP Hot Water Pump
41. HWR Hot Water Return
42. HWS Hot Water Supply
43. HX Heat Exchanger
44. IU: Induction Unit
45. LAN: Local area network.
46. MER: Mechanical Equipment Room.
47. NC: Normally Closed
48. NO: Normally Open
49. OA: Outdoor Air
50. PID: Proportional Integral Derivative.
51. POT: Portable Operators Terminal.
52. RA: Return Air
53. RF: Return Fan
54. RH: Relative Humidity

55. RTU: Roof-top Unit
56. SA: Supply Air
57. SF: Supply Fan
58. SP: Static Pressure
59. TEMP: Temperature
60. UH: Unit Heater
61. UV: Unit Ventilator
62. VAV: Variable Air Volume
63. VFD: Variable Frequency Drive.
64. VRF: Variable Refrigerant Flow
65. VRV: Variable Refrigerant Volume
66. WSHP: Water Source Heat Pump

1.5 DEFINITIONS

A. Adjustable (adj.): Adjustable by the end user, through the supplied user interface.

B. Advanced Application Controllers (AACs): A fully programmable control module. This control module may be capable of some of the advanced features found in Building Controllers (storing trends, initiating read & write requests, etc.) but it does not serve as a master controller. Advanced Application Controllers may reside on either the Ethernet/IP backbone or on a subnet.

C. Alarm: The control system shall be configured to generate an alarm when this object exceeds user definable limits, as described in the Sequence of Controls.

D. Analog Value: An intermediate (software) point that may be editable or read-only. Editable AVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only AVs are typically used to display the status of a control operation.

E. Application Specific Controllers (ASCs): A pre-programmed control module which is intended for use in a specific application. ASCs may be configurable, in that the user can chose between various pre-programmed options, but it does not support full custom programming. ASCs are often used on terminal equipment such as VAV boxes or fan coil units. In many vendors' Design Professionalures ASCs do not store trends or schedules but instead rely upon a Building Controller to provide those functions.

F. BACnet Interoperability Building Blocks (BIBB): A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification.

G. BACnet/BACnet Standard: BACnet communication requirements as defined by the latest version of ASHRAE/ANSI 135 and approved addenda.

H. Binary Value: An intermediate (software) point that may be editable or read-only. Editable BVs are typically used to allow the user to set a fixed control parameter, such as a setpoint. Read Only BVs are typically used to display the status of a control operation.

I. Building Controllers (BCs): A fully programmable control module which is capable of storing trends and schedules, serving as a router to devices on a subnet, and initiating read and write requests to other controllers. Typically this controller is located on the Ethernet/IP backbone of the BAS. In many vendors' Design Professionalures a Building Controller will serve as a master controller, storing schedules and trends for controllers on a subnet underneath the Building Controller.

J. Control Systems Server: A computer(s) that maintain(s) the systems configuration and programming database.

K. Controller: Intelligent stand-alone control device. Controller is a generic reference to building controllers, custom application controllers, and application specific controllers.

L. Direct Digital Control: Microprocessor-based control including Analog/Digital conversion and program logic.

M. Furnished or Provided: The act of supplying a device or piece of equipment as required meeting the scope of work specified and making that device or equipment operational. All costs required to furnish the specified device or equipment and make it operational are borne by the division specified to be responsible for providing the device or equipment.

N. Gateway: Bi-directional protocol translator connecting control systems that use different communication protocols.

O. Install or Installed: The physical act of mounting, piping or wiring a device or piece of equipment in accordance with the manufacturer's instructions and the scope of work as specified. All costs required to complete the installation are borne by the division specified to include labor and any ancillary materials.

P. Integrate: The physical connections from a control system to all specified equipment through an interface as required to allow the specified control and monitoring functions of the equipment to be performed via the control system.

Q. Interface: The physical device required to provide integration capabilities from an equipment vendor's product to the control system. The equipment vendor most normally furnishes the interface device. An example of an interface is the chilled water temperature reset interface card provided by the chiller manufacturer in order to allow the control system to integrate the chilled water temperature reset function into the control system.

R. Local Area Network: Computer or control system communications network limited to local building or campus.

S. Loop or control loop: Most commonly a PID control loop. Typically a control loop will include a setpoint, an input which is compared to the setpoint, and an output which controls some action based upon the difference between the input and the setpoint. A PID control loop will also include gains for the proportional, integral, and derivative response as well as an interval which controls how frequently the control loop updates its output. These gains may be adjustable by the end user for control loop "tuning," but in self-tuning control loops or loops which have been optimized for a specific application the gains may not be adjustable.

T. Master-Slave/Token Passing (MS/TP): Data link protocol as defined by the BACnet standard.

U. Point-to-Point: Serial communication as defined in the BACnet standard.

V. Primary Controlling LAN: High speed, peer-to-peer controller LAN connecting BCs and optionally AACs and ASCs. Refer to System Design Professionalure below.

W. Protocol Implementation Conformance Statement (PICS): A written document that identifies the particular options specified by BACnet that are implemented in a device.

X. Router: A device that connects two or more networks at the network layer.

Y. Schedule: The control algorithm for this equipment shall include a user editable schedule.

Z. Trend: The control system shall be configured to collect and display a trend log of this object. The trending interval shall be no less than one sample every 5 minutes. (Change of Value trending, where a sample is taken every time the value changes by more than a user-defined minimum, is an acceptable alternative.)

AA. Web Services: Web services are a standard method of exchanging data between computer systems using the XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services can be used at any level within a Building Automation System (BAS), but most commonly they are used to transfer data between BAS using different protocols or between a BAS and a non-BAS system such as a tenant billing system or a utility management system.

BB. Wiring: Raceway, fittings, wire, boxes and related items.

1.6 QUALITY CONTROL

A. Installer and Manufacturer Qualifications

1. Installer shall have an established working relationship with the Control System Manufacturer and have, as a minimum, 5 years demonstrated experience with installation and support of the manufacturer's product
2. Installer shall have successfully completed Control System Manufacturer's control system training. Upon request, Installer shall present record of completed training including course outlines.

1.7 CODES AND STANDARDS

A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances for these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:

1. National Electric Code (NEC)
2. International Building Code (IBC)

    a. Section 719 Ducts and Air Transfer Openings
    b. Section 907 Fire Alarm and Detection Systems
    c. Section 909 Smoke Control Systems
    d. Chapter 28 Mechanical

3. International Mechanical Code (IMC)
4. ANSI/ASHRAE Standard 135, BACnet - A Data Communication Protocol for Building Automation and Control Systems

1.8 SYSTEM PERFORMANCE

A. Performance Standards. System shall conform to the following minimum standards over network connections. Systems shall be tested using manufacturer's recommended hardware and software for display through the user's web browser.

1. Graphic Display. A graphic with 20 dynamic points shall display with current data within 10 sec.
2. Graphic Refresh. A graphic with 20 dynamic points shall update with current data within 8 sec. and shall automatically refresh every 15 sec.
3. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, PID loops, and similar control logic shall automatically refresh within 6 sec.
4. Object Command. Devices shall react to command of a binary object within 2 sec. Devices shall begin reacting to command of an analog object within 2 sec.
5. Alarm Response Time. An object that goes into alarm shall be annunciated at the browser within 45 sec.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 sec.
7. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciation. Each user, connected to network accessing the system through their browser (workstation), shall receive alarms within 5 seconds of one another.
9. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.

    a. Table 1: Reporting Accuracy

        1) Note 1: Accuracy applies to 10%-100% of scale
        2) Note 2: For both absolute and differential pressure
        3) Note 3: Not including utility-supplied meters

A) MEASURED VARIABLE	B) REPORTED ACCURACY
c) SPACE TEMPERATURE	d) ±0.5ºC (±1ºF)
e) DUCTED AIR	f) ±0.5ºC (±1ºF)
g) OUTSIDE AIR	h) ±1.0ºC (±2ºF)
i) DEW POINT	j) ±1.5ºC (±3ºF)
k) WATER TEMPERATURE	l) ±0.5ºC (±1ºF)
m) DELTA-T	n) ±0.15º (±0.25ºF)
o) RELATIVE HUMIDITY	p) ±5% RH
q) WATER FLOW	r) ±2% OF FULL SCALE
s) AIRFLOW (TERMINAL)	t) ±10% OF FULL SCALE (*SEE NOTE 1*)
u) AIRFLOW (MEASURING STATIONS)	v) ±5% OF FULL SCALE
w) AIRFLOW (PRESSURIZED SPACES)	x) ±3% OF FULL SCALE
y) AIR PRESSURE (DUCTS)	z) ±25 PA (±0.1 IN. W.G.)
aa) AIR PRESSURE (SPACE)	bb) ±3 PA (±0.01 IN. W.G.)
cc) WATER PRESSURE	dd) ±2% OF FULL SCALE (*SEE NOTE 2*)

	ee) ff)	ELECTRICAL (A, V, W, POWER FACTOR)		gg)	±1% OF READING (*SEE NOTE 3*)
	hh)	CARBON MONOXIDE (CO)		ii)	±5% OF READING
	jj)	CARBON DIOXIDE (CO_2)		kk)	±50 PPM

B. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

1. Table 2: Control Stability and Accuracy

SCHEDULE 2 - CONTROLLED VARIABLE	SCHEDULE 3 - CONTROL ACCURACY	SCHEDULE 4 - RANGE OF MEDIUM
SCHEDULE 5 - AIR PRESSURE	SCHEDULE 6 - ±50 PA (±0.2 IN. W.G.) SCHEDULE 7 - ±3 PA (±0.01 IN. W.G.)	SCHEDULE 8 - 0-1.5 KPA (0-6 IN. W.G.) SCHEDULE 9 - ???25 TO 25 PA (0.TO 0.1 IN. W.G.)
SCHEDULE 10 - AIRFLOW	SCHEDULE 11 - ±10% OF FULL SCALE	
SCHEDULE 12 - SPACE TEMPERATURE	SCHEDULE 13 - ±1.0ºC (±2.0ºF)	
SCHEDULE 14 - DUCT TEMPERATURE	SCHEDULE 15 - ±1.5ºC (±3ºF)	
SCHEDULE 16 - HUMIDITY	SCHEDULE 17 - ±5% RH	
SCHEDULE 18 - FLUID PRESSURE	SCHEDULE 19 - ±10 KPA (±1.5 PSI) SCHEDULE 20 - ±250 PA (±1.0 IN. W.G.)	SCHEDULE 21 - MPA (1-150 PSI) SCHEDULE 22 - 0-12.5 KPA (0-50 IN. W.G.) DIFFERENTIAL

1.1 SUBMITTALS

A. Product Data and Shop Drawings: Meet requirements of Section 013000 on Shop Drawings, Product Data, and Samples. In addition, the .2 Contractor shall provide shop drawings or other submittals on hardware, software, and equipment to be installed or provided. No work may begin on any segment of this project until submittals have been approved for conformity with design intent. Drawings provided as electronic files on suitable solid state media (file format:
.PDF or comparable) and as 11" x 17" prints. Select and show submittal quantities appropriate to scope of work. Submittal approval does not relieve .2 Contractor of responsibility to supply sufficient quantities to complete work.

B. Submittals shall include:

1. Shop Drawings, Product Data, and Samples
   a. The BMS contractor shall submit a list of all shop drawings.

b. Submittals shall be in defined packages. Each package shall be complete, shall only reference itself, and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.

c. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work.

d. The BMS Contractor shall correct any errors or omissions noted in the first review.

e. At a minimum, submit the following:

- BMS network architecture diagrams including all nodes and interconnections
- Systems schematics, sequences, and flow diagrams
- Points schedule for each point in the BMS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address
- Detailed Bill of Material list for each system or application, identifying quantities, part numbers, descriptions, and optional features
- Control Damper Schedule including a separate line for each damper provided under this section and a column for each of the damper attributes, including Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type
- Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address
- Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type
- Details of all BMS interfaces and connections to the work of other trades
- Product data sheets or marked catalog pages including part number, photo and description for all products including software

C. Record Documentation:

1. Operation and Maintenance Manuals.

a. Copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media or USB Flash Drive, and include the following for the BMS provided:

- As-built system record drawings.
- Manufacturer’s product data sheets or catalog pages for all products including software
- System Operator’s manuals
- Archive copy of all site-specific databases and sequences
- BMS network diagrams
- Interfaces to all third party products and work by other trades

2. Central System Hardware and Software

a. A complete bill of material of equipment used indicating quantity, manufacturer, model number, and relevant technical.

b. Manufacturer's description and technical data such as product specifications and installation and maintenance instructions for items listed below and for relevant items furnished under

this contract not listed below:

1) Central Processing Unit (CPU) or web server
2) Monitors
3) Keyboards
4) Power supplies
5) Battery backups
6) Interface equipment between CPU or server and control panels
7) Operating System software - web server
8) Color graphic software
9) Third-party software

c. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show interface wiring to control system.
d. Network riser diagrams of wiring between central control unit and control panels.

3. Controlled Systems

a. Riser diagrams showing control network layout, communication protocol, and wire types.
b. A schematic diagram of each controlled system. The schematics shall have all control points labeled with point names shown or listed. The schematics shall graphically show the location of all control elements in the system.
c. A schematic wiring diagram of each controlled system. Label control elements and terminals. Where a control element is also shown on control system schematic, use the same name.
d. An instrumentation list (Bill of Materials) for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
e. A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system.
f. A point list for each control system. List I/O points and software points specified in the Sequence of Operations. Indicate alarmed and trended points.

4. Quantities of items submitted shall be reviewed but are the responsibility of the .2 Contractor.
5. BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface.

D. Project Record Documents. As-built documents shall be submitted for approval after final completion and shall include:

1. Project Record Drawings. As-built versions of submittal shop drawings provided as electronic files on suitable solid state media (file format: .PDF or comparable) and as 11" x 17" prints.
2. Testing and Commissioning Reports and Checklists.
3. Operation and Maintenance (O&M) Manual.
4. As-built versions of submittal product data.
5. Graphic files, programs, and database on suitable solid state media.
6. List of recommended spare parts with part numbers and suppliers provided at the request of the Client Agency.
7. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
8. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation or web server software, and graphics software.
9. Licenses, guarantees, and warranty documents for equipment and systems.
10. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions will be provided at the request of the Client Agency.

E. Training Materials: Provide course outline and materials for each class. Training shall be furnished via instructor-led sessions, computer-based training, or web-based training.

1.2 WARRANTY

A. Warrant work as follows:

1. Warrant labor and materials for specified control system free from defects for a period of 12 months after final acceptance. Control system failures during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Client Agency. Respond during normal business hours within 24 hours of Client Agency's warranty service request.
2. Work shall have a single warranty date, even if Client Agency receives beneficial use due to early system start-up. If specified work is split into multiple contracts or a multi-phase contract, each contract or phase shall have a separate warranty start date and period.
3. If the Professional determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, the Professional will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification. Date of acceptance shall begin warranty period.
4. Provide support related to web server software, project-specific software, graphic software, database software, and firmware that resolve the contractor-identified software deficiencies at no charge during warranty period. If available, Client Agency can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Client Agency's written authorization.
5. Exception: Contractor shall not be required to warrant reused devices except those that have been rebuilt or repaired and factory recertified. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Professional's acceptance.

1.3 Client AgencySHIP OF PROPRIETARY MATERIAL

A. Project-specific software and documentation shall become Client Agency's property. This includes, but is not limited to:

1. Graphics
2. Record drawings
3. Database
4. Application programming code
5. Documentation

1.4 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Sensors and Transmitters:

1. Airflow stations
2. Flow Meters
3. Flow switches
4. Refrigerant pressure and temp sensor wells & sockets
5. Hydronic Temp sensor wells and sockets
6. H2O Pressure Differential/Flow Switches

B. Control Valves:

1. Control valves

C. Control Dampers:

1. Automated Dampers

1.5 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Field Installed Devices. HVAC equipment that is provided with packaged controls will be provided with all components necessary to complete the sequence of operations. Necessary components shipped loose from the equipment manufacturer shall be field installed by the ATC vendor.

1.6 PRODUCTS NOT FURNISHED OR INSTALLED UNDER BUT INTEGRATED WITH THE WORK OF THIS SECTION

A. General: The Installer furnishing the DDC network shall meet with the Installer(s) furnishing each of the following products to coordinate details of the interface between these products and the DDC network. The Client Agency or his designated representative shall be present at this meeting. Each Installer shall provide the Client Agency and all other Installers with details of the proposed interface including PICS for BACnet equipment, hardware and software identifiers for the interface points, network identifiers, wiring requirements, communication speeds, and required network accessories. The purpose of this meeting shall be to insure there are no unresolved issues regarding the integration of these products into the DDC network. Submittals for these products shall not be approved prior to the completion of this meeting.

B. Central Heating Equipment

1. The boiler vendor shall furnish boilers with an interface to the control and monitoring points specified in the sequence of operations. These specified points shall be the minimum acceptable interface to the boiler. The connection to these points shall be by one of the following methods:

a. Hardwired connection such as relay, 0-10VDC, or 4-20mA.
b. BACnet/IP network connection.
c. BACnet over ARCNET network connection.
d. BACnet MS/TP network connection.
e. Modbus protocol is an acceptable alternative.

C. Central HVAC Equipment

1. Unit shall be furnished configured to accept control inputs from an external building automation system controller as specified in the sequence of operations. Factory mounted safeties and other controls shall not interfere with this controller.

D. Variable Frequency Drive

1. The variable frequency drive (VFD) vendor shall furnish VFDs with an interface to the control and monitoring points specified in the sequence of operations. These specified points shall be the minimum acceptable interface to the VFD. The connection to these points shall be by one of the following methods:
2. Hardwired connection such as relay, 0-10VDC, or 4-20mA.
3. BACnet/IP network connection.
4. BACnet over ARCNET network connection.
5. BACnet MS/TP network connection.
6. Modbus MS/TP or IP is an acceptable alternative.

E. Any additional integral control systems included with the products integrated with the work of this section shall be furnished with a BACnet interface for integration into the Direct Digital Control System described in this specification.

1.7 Work By Others

A. The demarcation of work and responsibilities between the BMS Contractor and other related trades shall be as outlined in the BMS RESPONSIBILITY MATRIX.

BMS Responsibility Matrix

Work	Furnish	Install	Low Volt. Wiring/Tube	Line Power
BMS low voltage and communication wiring *[1] (note 1)	BMS	BMS	BMS	N/A
VAV box controller (note 2)	BMS	23*[2]	BMS	26
BMS conduits and raceway	BMS	BMS	BMS	BMS
Automatic dampers (non-factory)	BMS	23	N/A	N/A
Automatic valves	BMS	23	BMS	N/A
VAV boxes	23	23	N/A	N/A
Pipe insertion devices and taps including thermowells, flow and pressure stations.	BMS	23	BMS	BMS
BMS Current Switches.	BMS	BMS	BMS	N/A
BMS Control Relays	BMS	BMS	BMS	N/A
Power distribution system monitoring interfaces	26	26	BMS	26
BMS interface with Chiller controls	BMS	BMS	BMS	BMS
Chiller controls interface with BMS	23	23	BMS	26
Elect. Baseboard and unit heater controls (note 3)	23	26*[3]	N/A*[3]	26
ADD OTHER THIRD-PARTY EQUIPMENT HERE	N/A	N/A	N/A	N/A
All BMS Nodes, equipment, housings, enclosures and panels.	BMS	BMS	BMS	BMS
Smoke Detectors (note 4)	26	26	26/BMS *[4]	26
Fire/Smoke Dampers (note 5)	23	23	26/BMS *[5]	26
Fire Dampers	23	23	N/A	N/A
Chiller Flow Switches	23	23	BMS	N/A
Boiler wiring	23	23	23	23
Water treatment system	23	23	23	26
VSDs	23/BMS*[7]	26	BMS	26
Refrigerant monitors	23/BMS*[7]	BMS	BMS	26
Computer Room A/C Unit field-mounted controls	23	23	BMS	26
Fire Alarm shutdown relay interlock wiring	26	26	26	26
Fireman’s Smoke Control Override Panel	26	26	26	26
Fan Coil Unit controls	BMS	BMS	BMS	26
Cabinet/Unit Heater controls (note 6)	BMS/23*[6]	26/BMS*[6]	BMS	26
Packaged RTU space mounted controls	23	BMS	BMS	26

Work	Furnish	Install	Low Volt. Wiring/Tube	Line Power
Packaged RTU factory-mounted controls	23	23	BMS	26
Packaged RTU field-mounted controls	BMS	BMS	BMS	26
Cooling Tower Vibration Switches	23	23	26/BMS*7	26
Cooling Tower Level Control Devices	23	23	26/BMS*7	26
Cooling Tower makeup water control devices	23	23	26/BMS*7	26
Starters, HOA switches	26	26	N/A	26
Control damper actuators	BMS	BMS	BMS	26

Footnotes:

*1. BMS low voltage and communications wiring: BMS Ethernet communications cable and IP infrastructure furnished and install by Division 26 Electrical Contractor or Others.

*2. VAV box controller factory installation would normally be by Division 23 Mechanical who furnishes the VAV boxes; could be by BMS for field installation of special controllers, see Row #2 of the BMS Responsibility Matrix above.

*3. Electric Baseboard Heating Controls – for line voltage stand-alone controls: furnished by Division 23 Mechanical Contractor who furnishes the baseboard units; line voltage controls installed and connected by Division 26 Electrical Contractor. Alternately, controls may be furnished and installed by BMS Contractors for projects requiring Baseboard Heating controls to be integrated into the BMS. Refer to Section 230993 SEQUENCE OF OPERATIONS. Division 23 Mechanical contractor owns responsibility to coordinate with BMS on scope.

*4. Smoke Detector also wired to shut down AHU/HVAC. Division 26 to provide local shut down relay at AHU. BMS to wire relay to AHU.

*5. Fire/Smoke Dampers: In most cases fire alarm control modules will be the most effective and flexible way of achieving this interface. If specifically required based on project specification, BMS Contractor to provide and ensure OPEN/CLOSE control of Fire/Smoke dampers as coordinated between BMS HVAC systems sequences, controls and overrides, and the Fire Alarm system control status priorities and overrides. Coordinate with Division 26 to provide duct detectors or fire alarm control modules for air handling unit and exhaust system shutdown and smoke control inputs to the DDC system. Ensure that the logic matrix for the fire alarm devices to trigger a HVAC response is clearly specified.

*6. Cabinet/Unit Heater Controls – for line voltage stand-alone controls: furnished by Division 23 Mechanical Contractor who furnishes the Cabinet/Unit Heaters; line voltage stand-alone controls installed and connected by Division 26 Electrical Contractor. Even for stand-alone controls, it is common for the line voltage TStat and associated interlock wiring to be installed by the BAS. The power to the UH/CUH is performed by the Division 26 contractor. Alternately, controls may be furnished and installed by BMS Contractors for projects requiring Cabinet/Unit Heater controls to be integrated into BMS. Refer to Section 230993 SEQUENCE OF OPERATIONS. Division 23 Mechanical contractor owns responsibility to coordinate with BMS on scope.

*7. Division 23 Mechanical contractor owns responsibility to coordinate with BMS on scope.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Client Agency. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet

internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135, BACnet.

B. Install new wiring and network devices as required to provide a complete and workable control network.

C. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.

D. Internetwork operator interface and value passing shall be transparent to internetwork Design Professionalure.

1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, and control algorithms shall be viewable and editable from each internetwork controller.
2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute control strategies specified in the Sequence of Operations. An authorized operator shall be able to edit cross-controller links by typing a standard object address or by using a point-and-click interface.

E. Building Control Panels and Controllers with real-time clocks shall use the BACnet Time Synchronization service. System shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight saving and standard time as applicable.

F. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring.

G. System shall support Web services data exchange with any other system that complies with XML (extensible markup language) and SOAP (simple object access protocol) standards. Web services support shall as a minimum be provided at the workstation or web server level and shall enable data to be read from or written to the system.

1. System shall support Web services read data requests by retrieving requested trend data or point values (I/O hardware points, analog value software points, or binary value software points) from any system controller or from the trend history database.
2. System shall support Web services write data request to each analog and binary object that can be edited through the system operator interface by downloading a numeric value to the specified object.
3. For read or write requests, the system shall require user name and password authentication and shall support SSL (Secure Socket Layer) or equivalent data encryption.
4. System shall support discovery through a Web services connection or shall provide a tool available through the Operator Interface that will reveal the path/identifier needed to allow

   a third party Web services device to read data from or write data to any object in the system which supports this service.
5. Direct access to trend data shall be provided in order to facilitate historical information stored by the system.

2.3 BMS SYSTEM ARCHITECTURE

A. Automation Network

1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.

2. The BMS shall network multiple user interface clients, application and data servers, network engines, system controllers and application-specific controllers including but not limited to:

    a. Application and Data Server

    b. Network Engines

    c. Network Control Engines

    d. Equipment Controllers

    e. VAV Box Controllers

    f. Third Party BACnet controllers and peripheral devices with compatibility listed by BACnet International

    g. Application and Data Server

3. All BMS devices on the automation network shall be capable of operating at a minimum communication speed of 100 Mbps, with full peer-to-peer network communication.

4. Network Security – To protect the BMS from unauthorized users and computer hackers the Automation Network shall support HTTPS with TLS 1.2 between components, including the Application and Data Server(s), Network Engines, Mobile User Interface and Site Management Portal. Self-signed certificates are installed on supported products, with the option of configuring trusted certificates. Computing devices supplied by the BMS vendor will automatically shut down unused ports to deter unauthorized access.

5. The automation network will be compatible with other enterprise-wide networks. Automation network components of the BMS shall be connected to the Owner's enterprise network and share resources with it by way of standard networking devices and practices.

    a. Owner shall provide and maintain all infrastructure components for the Automation network, including switches, routers, firewalls, etc.

    b. All data drops and IP addresses to and for BACnet IP components of the BMS shall be provided by the Owner.

B. Control Network

1. Network Engines shall provide supervisory control over the control network and shall selectively support the following communication protocols:

    a. BACnet Standard Master-Slave/Token-Passing (MS/TP) Bus Protocol ASHRAE SSPC-135:

        1) The Network Engines shall be BTL listed/certified.

        2) The Network Engines shall be tested and certified as a BACnet Building Controller (B-BC) profile.

    b. The Johnson Controls N2 Field Bus

    c. Modbus® TCP and RTU

2. Control networks shall provide either "Peer-to-Peer", Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.

3. Control network shall support digital controllers as indicated in plans and specifications.

4. Default control network communication protocol for this project shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.

5. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.

C. Integration

1. Direct Protocol (Integrator Panel)

a. The BMS system shall include appropriate hardware equipment and software to allow bi-directional data communications between the BMS system and third party manufacturers' control panels. The third party manufacturer must provide the same capability. The BMS shall have the ability to receive, react to, and return information from multiple building systems, including but not limited to the chillers, boilers, variable frequency drives, and power monitoring system.

b. All data required by the application shall be mapped into the Network Engine's database, and shall be transparent to the operator.

c. Point inputs and outputs from the third party controllers shall have real-time interoperability with BMS software features such as: Control Software, Energy Management, Custom Process Programming, Alarm Management, Historical Data and Trend Analysis, Totalization, and LAN Communications.

2. BACnet Protocol Integration – BACnet

a. The neutral protocol used between systems will be BACnet MSTP/IP and comply with the ASHRAE BACnet standard 135.

b. A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.

c. The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

2.4 USER INTERFACE

1. Dedicated Web Based User Interface

a. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically, it must be implemented to conform to the following interface standards.

i. Edge or Google Chrome or Safari for user interface functions.

ii. Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions.

iii. Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports.

iv. Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.

b. PC Hardware/Software – The personal computer(s) shall be configured as specified in the Computing Hardware and Software section.

2. Mobile, Web Based, User Interface (MUI)

a. General

i. The mobile, web-based, user interface shall be HTML5-compliant and provide access to the system from smartphones, tablets, portable and desktop computers. User Interfaces that require software installation on the client device (e.g. Java, MicrosoftSilverlight®, Adobe® Flash®), or software downloads from an online app store shall not be acceptable for these purposes.

ii. The mobile user interface shall provide system operators with a simple location-based navigation approach to finding information, including the ability to search for any location by name and to bookmark a location in a standard browser.

iii. The mobile user interface shall organize and display information using customer specific locations and spaces. At a minimum, the user interface shall provide:

- Organization of all space, equipment and point information in a familiar way (using standard equipment names and location descriptions), reducing the need for extensive training prior to use.
- A navigation mechanism or tree for users to select the specific location or space for accessing information – only spaces and locations in the navigation tree or equipment serving that space, nothing more.
- The ability to search for and/or bookmark any location, space, or equipment by name for quick access to critical or troublesome areas.
- Application of the same navigation mechanisms across any client device (e.g. Smart phone, tablet, personal computer) for consistency and ease of use.

iv. The same user interface elements shall be accessible from any type of personal computer or mobile device running any type of operating system supported (e.g. iOS, Android, Windows®). It shall automatically adapt and optimize the display for the screen size and touch screen navigation.

v. The user interface shall provide support for up to 50 concurrent users from individuals with defined access to the system.

b. Navigation Trees

i. A dedicated location based navigation tree shall be provided as part of the user interface in order to navigate to specific places within the facility on a hierarchical basis (typ. Facility, Building, Wing, Floor, Room.)

ii. The location-based tree shall use place names familiar to the operator without training or familiarization regarding special codes and conventions utilized in the generation of the BMS.

iii. Clicking or tapping on a location name in the tree shall display the home page associated with the space and simultaneously expand the tree to display the next level of spaces below the one selected.

iv. It shall be possible for qualified users to view a navigation tree of devices connected to the BMS network in order to enable troubleshooting of equipment and communications. Clicking or tapping on the Network Icon at the top of the Navigation Tree will access this alternate view. Users without the necessary access rights shall not see the Network Icon.

v. A click or tap on a device in the network tree shall display a dashboard for that device including information regarding related equipment and access to a separate focus view of commandable points associated with the piece of hardware. A click or tap on such a point shall display a control dialogue box allowing the user to modify or command that point as indicated. The dialog box shall contain an annotation box for describing why the action was taken or special circumstances that apply.

vi. Specific hardware and software types in the Network tree shall also include access to one or more the following views in their dashboard depending on hardware type or network element (e.g. MS/TP trunk):

- Summary View
- Diagnostic View
- Network View
- Trend View

vii. It shall be possible to hide the Network Tree and return to the Spaces Tree at any time by clicking on the Spaces Icon above the tree.

viii. It shall be possible to restrict user access to any space in the Spaces Tree and thereby prevent manipulation of equipment associated with the space.

c. Dashboard Displays

i. The user interface shall provide the ability to view equipment visualizations, floor plans, and/or other graphics on mobile or desktop client devices in a browser environment, without the need for additional plugins or software. Graphics shall be accessible via a space (for floorplans, campus maps, etc.) or equipment dashboard.

ii. Standard dashboards shall be configured for each defined space including one of the following predefined or custom elements:

- Equipment Serving Space
- Potential Problem Areas
- Equipment Summary
- Graphic Display (if specified)
- Schedule

iii. Standard dashboards shall be configured for each system or device (typ. mechanical or electrical equipment) including the following predefined or custom elements:

- Trend
- Equipment Activity Summary
- Equipment Relationships Summary
- Equipment Data
- Graphic Display (if specified)
- Schedule

iv. Users with appropriate permissions shall have access to a Dashboards Manager that can change the display order of Summaries and Data elements, add or remove elements and apply custom dashboards layouts to equipment and space by type.

v. Dashboard Manager shall apply dashboards to spaces or equipment based on the viewing platform (Desktop/Tablet or Phone) in order to tailor the user experience to the needs of the specific user base.

vi. Default dashboard displays by space and equipment type shall be created per the guidelines in this specification or by mutual agreement with the owner's representative.

d. Alarm Management

i. The user interface shall provide a single display of all potential issues in a facility including items currently in alarm, warning, override, out-of-service and offline.

ii. The user interface shall provide notification of new alarms, visually and audibly.

iii. The user interface shall provide the ability to view a summary of alarms, including a chart of the number of alarms in each of the defined alarm priority ranges. The priority ranges should be filterable.

iv. The user interface shall provide the capability to view multiple occurrences of the same alarm, ultimately providing the ability to acknowledge or discard all occurrences of the alarm in a single action.

v. The user interface shall provide the capability to view, and filter on, all alarms present in a well-defined mechanical system using the equipment serving equipment relationships.

vi. The user interface shall provide the capability to acknowledge and discard all occurrences of at least 1000 alarms in one operation.

vii. The user interface shall provide the user with the understanding of what physical space is being affected when an alarm occurs. The user interface shall provide the ability to filter alarms by physical space affected when the alarm occurred.

viii. The user interface shall provide the capability to monitor alarms 24/7 without requiring an active login to the system, accessible via segregated web page. The user interface shall provide the capability to enabled or disable the 24/7 alarm monitor mode if desired.

ix. The user interface shall provide the capability to annotate alarms using a pre-defined selection list or by providing custom text.

x. The user interface shall provide the capability to filter down alarm list and bookmark the filtered list, allowing automatic filtering to be applied when the bookmark is accessed.

xi. It shall be possible to export a .csv or .pdf copy of the currently displayed alarm list.

xii. If an alarm is not acknowledged or discarded by recipients within a user-selected time, the alarm shall be sent to an additional set of recipients.

e. Equipment Activity Summary

i. The user interface shall provide a filterable, single display, of all activity related to a specific piece of equipment including user changes, discarded user changes, pending alarms, discarded alarms, and acknowledged alarms for at least one year of historical data.

ii. Items shall be listed in timed order with the latest activity at the top of the list.

iii. Filters shall allow only specific activities for specific data points occurring within a specific time and date window to be displayed.

iv. It shall be possible to export a .csv copy of the currently displayed summary by clicking or tapping on the export icon.

v. It shall be possible to create a custom trend graph containing the data shown in the currently displayed summary by tapping or clicking on the trend icon in the header bar and selecting the specific points to trend in the resulting selection panel.

vi. Clicking on the information icon in front of any displayed activity listed in the summary shall expand the display to include the name of the user, server time, value prior to the activity, the ability to annotate the activity and a user selectable icon for displaying a trend graph of the point.

f. Equipment Relationships Summary

vii. The user interface shall provide a summary of all equipment and spaces related to the operation of the system or device currently selected for viewing.

viii. The user interface shall include the capability to navigate to the home page of any related piece of equipment or space with a single click or tap on the desired element.

g. Equipment Serving Space Summary

i. The user interface shall provide a summary of all mechanical and electrical equipment as defined in the points list that serves a selected space from the navigation tree.

ii. The summary shall be capable of including a subset of the viewable points for each system representing the key elements of interest to operators without subjecting them to long lists of points irrelevant to basic operation.

iii. Clicking or tapping on any item in the summary shall navigate to the item's assigned home page in the user interface.

iv. It shall be possible to view a custom trend of information contained in the summary with a single click of the trend icon residing in the title header.

v. It shall be possible to display specific systems and points by filtering equipment types desired.

vi. Because the data is intended to be a snapshot of the current conditions in the space it shall not dynamically update but a click or tap on the update icon at any time performs that function.

h. Potential Problem Areas

i. The user interface shall provide a summary of all points in the system related to the space that are not operating correctly (e.g. alarm, off normal or not communicating correctly) in order to provide the operator with a quick update on current conditions.

ii. The information shall include:

- Point status (via color)
- Point name
- Value of the point when the summary was taken
- Equipment that contains the offending point
- Space that is served by that equipment

iii. Data points in the summary may be filtered by one or more types of off-normal condition (e.g. above setpoint, offline and overridden).

iv. The summary may be exported in .csv format for inclusion in spreadsheets or other documents.

i. Equipment Summary

i. The user interface shall provide a summary that allows the user to compare all similar equipment that serves the space as well as downstream (child) spaces in order to evaluate conditions quickly and determine patterns for troubleshooting purposes.

ii. Each unique equipment type shall be selectable and display a representative set of values along with the space(s) being served by the device. Equipment types can be selected from a dropdown menu in the summary.

iii. Clicking or tapping on a selected device in the summary shall navigate to the home page for that piece of equipment while clicking or tapping a data point shall display the command panel for that point.

iv. It shall be possible to export a .pdf copy of the currently displayed summary by clicking or tapping on the export icon.

v. It shall be possible to create a custom trend graph containing the data shown in the currently displayed summary by clicking on the trend icon in the header bar and selecting the specific points to trend in the resulting selection panel.

j. User Defined Summaries

i. Provide the capability to view, command, and modify large quantities of similar data in summaries without the use of a secondary application (e.g. a spreadsheet). These summaries shall be generated automatically or user defined. User defined summaries shall allow up to seven user defined columns describing attributes to be displayed including custom column labels with up to 100 rows per summary.

k. Trend

i. The user interface shall provide the capability to view historical trend data from multiple pieces of equipment in both bar and line formats.

ii. The user shall have the ability to navigate to a selection list of frequently viewed trends.

iii. Trend graphs shall have to ability to be smartly auto-generated based on equipment and space relationships.

iv. The user shall have the ability to view up to 3 graphs in a single screen and select which data points to plot on each to help with readability.

v. Each graph shall include a dedicated selection icon to export a copy of the graphic and data in .pdf format or the data only as a .csv file.

vi. Trend graphs shall allow the plotting of non-trended point's default values.

vii. The user shall have the ability to add any trended to point a custom trend graph.

viii. The user shall have the ability to save trend graphs for reference later.

ix. The user shall be able to specify the duration of time and aggregation period for each trend line.

x. The user shall have the ability to decide whether to show raw or aggregate trend data.

l. Operator Access

i. The user interface shall provide the ability to segment access to building data based on the space(s) or location(s) the user is physically located in and/or manages. The user interface shall provide the capability to assign “inherited” space permissions and the ability to assign user’s space based access in bulk.

ii. The user interface shall provide the ability to segment access to building data based on the space(s) or location(s) the user is physically located in and/or manages. The user interface shall provide the capability to assign “inherited” space permissions and the ability to assign user’s space based access in bulk.

m. Graphics

i. The user interface shall display an equipment visualization or graphic within the context of its associated space (building, floor, room, etc.) or equipment dashboard.

ii. Graphics shall include the ability to define individual information layers for operator selection in order to clarify systems status and simplify operation on mobile devices. Where desired a master layer may be defined to include important information about the facility on all graphic screens.

iii. Graphics shall support the use of photo-realistic symbols as well as color change and animation to match the status of the related system control point.

iv. It shall be possible to export a time stamped .pdf file of the graphic being viewed in order to communicate the current conditions in the space or the equipment being viewed and to provide a historic record.

v. An integral graphic manager shall be provided including the following features and capabilities:

- Creation and modification of graphics from any HTML5 capable browser without the need for additional plug-ins or software packages.
- Access to a full suite of pre-defined templates for air and water sourced HVAC applications as well as the ability to add custom templates as created for other use. Pre-aliased graphic templates may be defined and saved for repetitive representations of common mechanical and electrical equipment.
- A full suite of pre-defined three dimensional symbols for mechanical and electrical systems as well as all line, text and shape tools required for integration into a graphic with zoom and pan capabilities on multiple platforms and in multiple browsers.
- The ability to search and replace items in multiple graphics with a single command.
- The ability to import and insert photos and images into the graphic.
- The ability of the graphics manager to create and edit graphics including the ability to bind graphic elements to the values and conditions of system points in both an on-line and off-line mode.
- The ability to create and import custom SVG symbols that can be selectable from the graphical palette and rendered at runtime.

vi. As required, the BMS Contractor shall provide software licenses in the name of the owner for programming, configuration and graphics building tools to allow designated representatives to make changes, modifications or additions to the system. While future updates or revisions may

require an update fee, the owner shall incur no additional cost if they choose not to update. Systems that require any annual or time-limited licensing fees shall not be permitted.

n. Scheduling

i. The user interface shall provide the capability to display, in a singular view, all of the effective schedules in the context of the space (building/floor/room, etc.) or equipment that the schedule effects. The software should have the ability to display an effective schedule, for the present, or a future date.

ii. The user interface shall provide a report of all schedules affecting a space or equipment. The report shall provide the user details of events that comprise the weekly schedule and exception schedule(s). The report shall provide a means of viewing individual breakout scheduling elements for Weekly Schedule, Exceptions and Default Commands.

iii. The user interface shall provide the capability to efficiently change or modify schedules in mass quantities. This includes the capability to add, in bulk, exceptions to schedules, in addition to assigning, in bulk, weekly schedules.

o. Command and Control

i. It shall be possible to command system analog and binary points via a dropdown menu accessed by clicking or tapping on the value shown in any equipment summary or graphic display and completing the task in the resultant menu including an optional annotation.

ii. Commanding multiple points shall be possible on displays where multiple like system elements can be chosen.

iii. The user interface shall support users adding notes on their commands.

iv. The user interface shall support a choice of either permanent or temporary commands.

p. Cyber Health Dashboard

i. The Cyber Health Dashboard shall provide a centralized view of potential cybersecurity related issues or system issues, grouped into critical issues, potential risks, and informational items.

ii. The Cyber Health Dashboard shall identify user account information, including:

a. Total number of users

b. Dormant users

c. Active users

d. Locked users

e. Temporary users

f. Disabled users

g. Users with Administrator role

h. Policy related information

iii. The Cyber Health Dashboard shall indicate out-of-date software.

iv. The Cyber Health Dashboard shall identify when security certificates are set to expire.

v. The Cyber Healthy Dashboard shall provide insight into user activity such as number of successful logins, unsuccessful logins, and locked out accounts.

q. Involvement

i. The user interface shall provide in a single screen, a way to visualize all interactions (I.e. - commands, writes, references) with a single object.

ii. The interface shall provide the ability to filter out any interactions (i.e. commands, writes, references) that are not pertinent.

iii. The user interface shall allow seamless navigation between one object's Involvement view to another object's.

r. System-level Activity

i. The user interface shall provide a timeline view of all audits that occur in the system, including:

a. Logins attempts with user specified

b. Add, delete, modification of objects

c. Commands

s. Search

ii. Typing a text string in the Search box shall display a list of all occurrences of that string in the mobile user interface. When a string is represented in the description of a space or network element, selecting it shall display its default dashboard.

iii. Clicking or tapping on the Advanced Search Icon shall display the Advanced Search dialog box permitting the following:

- Search by Space and Equipment, Equipment Definition or Network Reference
- Filter the search by wildcard name or object type
- Multi-selection of objects for commanding or the creation of reports including Trend, Alarm, Audit and Activity for a specific period of time

3. Associated Application Components

t. Security/Passwords

i. Multiple-level passwords access protection shall be provided via roles and permissions. The feature will allow the system to base access on a user's job title or role and allow the user/manager access interface control, display, and database manipulation capabilities based on an assigned password.

ii. Roles may be copied and altered to meet specific roles and permissions based on the particular policies.

iii. Each user shall have the following: a user account name (with a maximum of 30 characters), a complex password or passphrase (with a min of 8 characters and a max of 50 characters), other user account policies (such as session timeout), timesheet access based on day of the week and time of day, and specific user view.

iv. The system shall allow each user to change his or her password at will.

v. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.

vi. A maximum of 150 categories may be used to determine or assign areas of responsibilities to each user account. A maximum of 13 (of the 150) named categories which are specifics such as "No Access, View, Advanced Review, Operate, Intervene, Diagnostic, Manage Item Events, Manage Energy, and Configure Items".

vii. A minimum of 100 unique passwords shall be supported.

viii. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.

ix. Operators shall be further limited to only access, command, and modify those buildings, systems, and subsystems for which they have responsibility. Provide a minimum of 100 categories of systems to which individual operators may be assigned.

x. The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system

shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

xi. Each login attempt is recorded in the system Audit Log with the option to record the IP address of the PC that made the login.

u. Screen Manager

i. The system will allow a customized image on the login screen (e.g. organization name, logo).

ii. User View navigations can be displayed as either a set of tabs or a drop down list.

iii. Allows user preference for assigning of a background color for when an object is Out of Service which will enable the operator to quickly distinguish points that have been commanded to this state.

iv. The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

v. Historical trending and data collection

i. Each Network Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

- Any point, physical or calculated, may be designated for trending. Two methods of collection shall be allowed:
  a) Defined time interval
  b) Upon a change of value
- Each Network Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

ii. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in SQL database format.

iii. The system shall provide data to enable optimization capabilities including fault detection and diagnostics, advanced analytics and central plant optimization without the need of a gateway or additional hardware.

w. Database Management

i. Where a separate SQL database is utilized for information storage the System shall provide a Database Manager that separates the database monitoring and managing functions by supporting two separate windows.

ii. Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the Building Automation application.

iii. The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:

- Backup
- Purge
- Restore

iv. The Database Manager shall support four tabs:

- Statistics – shall display Database Server information and Trend, Alarm (Event), and Audit information on the Databases.
- Maintenance – shall provide an easy method of purging records from the Server trend, alarm (event), and audit databases by supporting separate screens for creating a

backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.

- Backup – Shall provide the means to create a database backup file and select a storage location.
- Restore – shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.

v. The Status Bar shall appear at the bottom of all Database Manager Tabs and shall provide information on the current database activity. The following icons shall be provided:

- Ready
- Purging Record from a database
- Action Failed
- Refreshing Statistics
- Restoring database
- Shrinking a database
- Backing up a database
- Resetting internet information Services
- Starting the Device Manager
- Shutting down the Device Manager
- Action successful

vi. The Database Manager monitoring functions shall be accessed through the Monitoring Settings window and shall continuously read database information once the user has logged in.

vii. The System shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

viii. The Monitoring Settings window shall have the following sections:

- General – Shall allow the user to set and review scan intervals and start times.
- Email – Shall allow the user to create and review e-mail and phone text messages to be delivered when a Warning or Alarm is generated.
- Warning – shall allow the user to define the Warning limit parameters, set the Reminder Frequency, and link the e-mail message.
- Alarm – shall allow the user to define the Alarm limit parameters, set the Reminder Frequency, and link the e-mail message.
- Database login – Shall protect the system from unauthorized database manipulation by creating a Read Access and a Write Access for each of the Trend, Alarm (Event) and Audit databases as well as an Expert Mode required to restore a database.

ix. The Monitoring Settings Taskbar shall provide the following informational icons:

- Normal – Indicates by color and size that all databases are within their limits.
- Warning – Indicates by color and size that one or more databases have exceeded their Warning limit.
- Alarm – Indicates by color and size that one or more databases have exceeded their Alarm limit.

x. The System shall provide user notification via Taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

2.5 Network Engines

A. General

a. The Network Engine shall be a fully user-programmable, supervisory controller. The Network Engine(s) shall monitor the network of distributed equipment controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Engine(s).

b. Automation network – The Network Engine(s) shall reside on the automation network and shall support a subnet of system controllers.

c. User Interface – Each Network Engine shall have the ability to deliver a web-based User Interface. All computers connected physically or virtually to the automation network shall have access to the web-based user interface.

d. Processor – The Network Engine(s) shall be microprocessor-based with a minimum word size of 32 bits. The Network Engine(s) shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. Network Engine(s) size and capability shall be sufficient to fully meet the requirements of this Specification.

e. Memory – Each Network Engine shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

f. Secure Boot – The Network Engine(s) shall prevent malicious or unauthorized software applications from loading during the system startup process.

g. User Authentication – The Network Engine(s) shall support local user authentication.

h. Password Security – Access to the Network Engines' embedded user interface shall require a password of 8 to 50 characters including a minimum of one lower case letter, one upper case letter, one number, and one special character. An alarm shall be generated after three unsuccessful attempts within 15 minutes, and the user shall be denied access until permission is renewed by a system administrator.

i. Network Security – Communication between the Network Engine and other system networked devices including additional Network Engines, Application and Data Servers, Open Data Servers (BACnet listed OWS), and user interface clients shall be encrypted and support HTTPS with Transport Level Security (TLS) Version 1.2. Self-signed certificates are to be provided with the option of configuring trusted certificates.

j. Hardware Real Time Clock – The Network Engine(s) shall include an integrated, hardware-based, real-time clock, with a supercapacitor to maintain time for a minimum of 72 hours during a power loss. Controllers using a battery to maintain time during a power loss shall not be acceptable.

k. Diagnostics – The Network Engine(s) shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Engine(s) shall provide both local and remote annunciation of any detected component failures or repeated failures to establish communication.

l. Power Failure – In the event of the loss of normal power, the Network Engine(s) shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

   xi. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

   xii. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

m. Certification – The Network Engine(s) shall meet and be listed to the UL 916 Standard for Energy Management Equipment and be FCC Compliant to CFR47, Part 15, Subpart B, Class A.

n. Device Integration – The Network Engine(s) shall support integrating networked devices using the following communication protocols on the device/controller network:

   xiii. Primary protocol support: The Network Engine(s) shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135 on the controller network.

- The Network Engine(s) shall support Remote Field Bus integration via a BACnet IP to MS/TP router.
- The Network Engine(s) shall be tested and BTL listed/certified as a BACnet Building Controller (B-BC).
- A BACnet Protocol Implementation Conformance Statement shall be provided for the Network Engine(s).
- The Protocol Implementation Conformance Statement shall be submitted 10 days prior to bidding.

xiv. Optional protocol support:

- The Network Engine shall support LonWorks enabled devices using a whitelisted USB-to-LonWorks FTT10 Free Topology Transceiver adapter.
- Johnson Controls N2 or third party N2 Open devices.

xv. The Network Engine(s) shall optionally support integration of networked devices using the following networking protocols:

- MODBUS RTU
- MODBUS TCP
- KNX - KNX is an open communication standard (EN 50090, ISO/IEC 14543) that many European manufacturers have applied to lighting controls, blinds and shutters, HVAC controls, security systems, energy management, audio, video, displays, and remote controls.
- M-Bus - M-Bus (Meter Bus) is a European standard (EN 1434-3) that applies primarily to energy and heat meters.
- C-CURE 9000 Access Control System
- victor Video Management System
- OPC UA

o. The Network Engine(s) shall include the following multi-color, flashing LEDs to indicate important operating conditions and status:

xvi. Heartbeat – to indicate each of the following states: operational (normal), powered but not operational, starting up, shutting down, or no power applied

xvii. Fault – to indicate if fault conditions have been detected

xviii. Ethernet Activity – to indicate if Ethernet Traffic is occurring or not occurring.

xix. Ethernet Link Speed – to indicate the speed of Ethernet Link (10, 100, or 1000 Mbps)

xx. Site Director – to indicate if the Network Engine has been designated as the Site Director

xxi. BACnet/IP – to indicate if the Network Engine is transmitting BACnet messages over BACnet/IP to other devices, including other Network Engines

xxii. USB -1 – to indicate if a supported device is connected, no device is connected, or an unsupported device is connected on USB port 1

xxiii. USB-1 – to indicate if a supported device is connected, no device is connected, or an unsupported device is connected on USB port 2

xxiv. FC BUS-# – to indicate if communication is occurring on FC Bus port # (1 or 2)

xxv. FC EOL-# – to indicate if the end-of-line termination switch # (1 or 2) is on or off

2. Network Engine – Flexible Sizing Options

p. The Network Engine shall support up to 50, 100 or 200 supervised devices across all supported integrations.

q. Communications Ports – The Network Engine(s) shall provide the following ports for connecting networkable devices

xxvi. Two (2) USB ports

xxvii. One (1) or Two (2) RS-485 ports

xxviii. One (1) Ethernet port

r. Provide Johnson Controls SNE10501, SNE11001 or SNE22001 or approved equal as indicated on plans.

2.6 Application and Data Server

1. Application and Data Server (ADS)

a. One Application and Data Server shall be provided for this project

b. The Application and Data Server shall be a software solution designed to manage the collection and presentation of large amounts of trend data, event messages, operator transactions, and system configuration data on the BMS.

c. The Application and Data Server shall act as site director for consolidating BMS information from Network Engines for integrated storage and presentation. The ADS shall not restrict access to the individual Network Engines ensuring optimal BMS accessibility in the event of individual component failure or a loss of communication.

d. The Application and Data Server shall act as a server for the following functionality as described in these specifications:

- Mobile user interface providing user friendly access to system information via site navigation by place or device.
- Site Management Portal functions and applications.
- System Configuration Tool controller configuration and programming.

e. Network Security – Communication between the Network Engines, Application and Data Server, and user interface clients shall be encrypted and support HTTPS with Transport Level Security (TLS) Version 1.2. Self-signed certificates are to be provided with the option of configuring trusted certificates.

f. The Application and Data Server shall be capable of supporting up to 50 simultaneous users via Web client access.

g. Supported Web Client operating systems:

xxix. Microsoft Windows 7, 8.1, 10 (Professional, Enterprise, Ultimate, Anniversary.)

xxx.Apple OS X 10.8, 10.9, 10.10, 10.11.

h. Supported Web Browsers:

xxxi. Google Chrome

xxxii. Microsoft Internet Explorer 11

xxxiii. Microsoft Edge

xxxiv. Apple Safari 11 or later

i. User Authentication – The Application and Data Server shall support local, Active Directory, and Microsoft 365 authentication.

j. Computer shall be configured as specified in the Computing Hardware and Software section of this specification.

k. Provide Johnson Controls MS-ADX or approved equal.

2.7 DDC Equipment Controllers

1. General Purpose Equipment Controller

   l. The General Purpose Equipment Controller (CGM) shall be a fully programmable, digital controller that communicates via the BACnet MS/TP protocol.

      i. The CGM shall support BACnet Standard ANSI/ASHRAE 135.

         - The CGM shall be BTL listed/certified.
         - The CGM shall be tested and certified as a BACnet Advanced Application Controller (B-AAC).
         - A BACnet Protocol Implementation Conformance Statement shall be provided for the CGM.
         - The Conformance Statement shall be submitted 10 days prior to bidding.

   m. The CGM shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

   n. CGM controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

   o. The CGM shall be assembled in a plastic housing with protection class IP20 (IEC529) and flammability rated to UL94-5VB.

   p. The CGM shall include an integral real-time clock and support time-based tasks which enables these field controllers to monitor and control:

      i. Schedules

      ii. Calendars

      iii. Alarms

      iv. Trends

   q. The CGM can continue time-based monitoring when offline for extended periods of time from a network.

   r. The CGM can operate as a stand-alone controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the equipment controllers.

   s. The CGM shall include troubleshooting LEDs to indicate the following conditions:

      i. Power—to indicate if the controller is powered or not powered

      ii. Fault – to indicate if the controller is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue

      iii. SA Bus – to indicate if SA Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin

      iv. FC Bus – to indicate if FC Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin

v. EOL – to indicate if the end-of-line termination switch is on or off

t. The CGM shall have the ability to transfer and apply firmware files to all SA Bus devices (XPM, IOM, and NS8000) connected to it.

u. The CGM shall include pluggable and labeled screw terminal blocks for all I/O, FC and SA Bus communication, and power wiring connections.

v. The CGM shall accommodate the direct wiring of analog and binary I/O field points with the following resolution.

i. Inputs – 24-bit analog-to-digital converter

ii. Outputs – +/- 200 mV accuracy in 0-10 VDC applications

w. The CGM shall support the following types of inputs and outputs supplied in the amounts required for the specified applications:

i. Universal Inputs – shall be configurable to monitor any of the following:

- 0-10 VDC analog input
- 4-20 mA analog input
- 0-600k ohms analog input
- Dry contact binary input

ii. Binary Inputs – shall be configurable to monitor either of the following:

- Dry Contact Maintained Mode
- Pulse Counter Mode

iii. Analog Outputs – shall be configurable to output either of the following:

- 0-10 VDC analog output
- 4-20 mA analog output

iv. Binary Outputs – shall output the following:

- 24 VAC Triac

v. Configurable Outputs – shall be capable of the following:

- 0-10 VDC analog output
- 24 VAC Triac binary output

x. The CGM shall have the ability to reside on a Field Controller Bus (FC Bus).

i. The FC Bus shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135.

ii. The FC Bus shall support communications between the CGMs and the Network Engine.

iii. The FC Bus shall also support peer-to-peer communications between non-supervisory devices, allowing these devices to communicate system data with each other directly, bypassing the supervisory network engine on the bus.

iv. The FC Bus shall support a minimum of 100 equipment controllers and/or expansion modules in any combination.

v. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the CGM and the furthest connected device.

y. The CGM shall include three (3) decimal rotary dial switches for setting the BACnet MS/TP device address.

z. The CGM shall have the ability to monitor and control a network of sensors and actuators over a SA Bus.

i. The SA Bus shall be a MS/TP Bus supporting BACnet Standard Protocol SSPC-135.

aa. The CGM shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over a MS/TP Bus.

bb. Provide Johnson Controls CGM or approved equal as shown on plans.

2. VAV Box Controller

cc. The VAV Box Controller (hereafter referred to as CVM) shall provide both standalone and networked DDC of pressure-independent, VAV terminal units.

dd. The CVM controller shall be a fully programmable, digital controller that communicates via BACnet MS/TP protocol.

i. The CVM shall support BACnet Standard ANSI/ASHRAE 135.

- The CVM shall be BTL listed/certified.
- The CVM shall be tested and certified as a BACnet Advanced Application Controller (B-AAC).
- A BACnet Protocol Implementation Conformance Statement shall be provided for the CVM.
- The Conformance Statement shall be submitted 10 days prior to bidding.

ee. The CVM shall include 14 preloaded single duct VAV box control applications to allow the CVM to be made fully operational without the need to create a custom program.

ff. The CVM shall employ finite state programming to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

gg. CVM controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

hh. The CVM shall be assembled in a plenum-rated plastic housing with protection class IP20 (IEC529) and flammability rated to UL94-5VB.

ii. The CVM shall include an integral real-time clock and support time-based tasks which enables these equipment controllers to monitor and control:

i. Schedules

ii. Calendars

iii. Alarms

iv. Trends

jj. The CVM can continue time-based monitoring when offline for extended periods of time from a network.

kk. The CVM shall include an integral differential pressure transducer and damper actuator. An additional configuration option shall be available that also includes an integral potentiometer for actual damper position feedback. All components shall be connected and mounted as a single assembly, removable as one piece.

ll. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 60 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.

mm. The CVM shall determine airflow by a state-of-the-art, digital, non-flow pressure sensor that supports automatic correction for polarity on high- and low-pressure DP tube connections to eliminate high- and low-pressure connection mistakes.

nn. The CVM shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.

oo. The CVM can operate as a stand-alone controller in applications that do not require a networked supervisory device or for network applications where it is preferred to have the scheduling, alarming, and/or trending performed locally in the equipment controllers.

pp. The CVM shall include troubleshooting LEDs to indicate the following conditions:

i. Power—to indicate if the controller is powered or not powered

ii. Fault – to indicate if the controller is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue

iii. SA Bus – to indicate if SA Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin

iv. FC Bus – to indicate if FC Bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin

v. EOL – to indicate if the end-of-line termination switch is on or off

qq. The CVM shall have the ability to transfer and apply firmware files to all SA Bus devices (XPM, IOM, and NS8000) connected to it.

rr. The CVM shall include pluggable screw terminal blocks for all I/O, FC and SA Bus communication, and power wiring connections.

ss. The CVM shall accommodate the direct wiring of analog and binary I/O field points with the following resolution.

i. Inputs – 24-bit analog-to-digital converter

ii. Outputs – +/- 200 mV accuracy in 0-10 VDC applications

tt. The CVM shall support the following types of inputs and outputs supplied in the amounts required for the specified applications:

i. Universal Inputs – shall be configurable to monitor any of the following:

- 0-10 VDC analog input
- 4-20 mA analog input
- 0-600k ohms analog input
- Dry contact binary input

ii. Binary Outputs – shall output the following:

- 24 VAC Triac binary outputs

iii. Configurable Outputs – shall be configurable of outputting the following:

- 0-10 VDC analog output
- 24 VAC Triac binary output

uu. The CVM shall have the ability to reside on a Field Controller Bus (FC Bus).

i. The FC Bus shall be a MS/TP Bus supporting BACnet Standard protocol SSPC-135.

vv. The CVM shall include three (3) decimal rotary dial switches for setting the BACnet MS/TP device address.

ww. The CVM shall have the ability to monitor and control a network of sensors and actuators over a SA Bus.

i. The SA Bus shall be a MS/TP Bus supporting BACnet Standard Protocol SSPC-135.

xx. The CVM shall have the capability to execute VAV box control sequences involving direct wired I/O points as well as input and output devices communicating over a MS/TP Bus.

yy. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.

zz. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.

aaa. The controller shall provide the ability to download and upload VAV box control application configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group.

bbb. Control setpoint changes initiated over the network shall be written to CVM non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.

ccc. The CVM controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.

ddd. The CVM controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.

eee. The CVM controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.

fff. The CVM controller shall have on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The CVM shall calculate Exponentially Weighted Moving Averages (EWMA) for each of the following metrics, which shall be available to the end user for efficient management of the VAV terminals.

ggg. The controller shall detect system error conditions to assist in managing the VAV zones.

hhh. The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The CVM would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.

iii. The CVM controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.

jjj. The CVM controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.

kkk. Provide Johnson Controls CVM or approved equal as shown on plans.

3. XPM expansion I/O module (XPM)
   a. The XPM provides additional input and output interfaces for use in digital controllers.
   b. The XPM shall communicate with controllers over the FC Bus or the SA Bus.
   c. The XPM shall support BACnet Standard ANSI/ASHRAE 135.
      i. The XPM shall be BTL listed/certified and carry the BTL Label.
      ii. The XPM shall be tested and certified as a BACnet Smart Actuator (B-SA).
      iii. A BACnet Protocol Implementation Conformance Statement shall be provided for the XPM.
      iv. The Conformance Statement shall be submitted 10 days prior to bidding.
   d. The XPM shall include pluggable screw terminal blocks for all I/O, SA/FC bus communication, and power wiring connections.
   e. The XPM shall include three (3) decimal rotary dial switches for setting the BACnet MS/TP device address.

f. The XPM shall accommodate the direct wiring of analog and binary I/O field points with the following resolution:
    i. Inputs – 24-bit analog-to-digital converter
    ii. Outputs – +/- 200 mV accuracy in 0-10 VDC applications
g. The XPM shall support the following types of inputs and outputs:
    i. Universal Inputs – shall be configured to monitor any of the following:
        - 0-10 VDC analog input
        - 4-20 mA analog input
        - 0-600k ohms analog input
        - Dry contact binary input
    ii. Binary Inputs – shall be configured to monitor either of the following:
        - Dry Contact Maintained Mode
        - Pulse Counter Mode
    iii. Analog Outputs – shall be configured to output either of the following:
        - 0-10 VDC analog output
        - 4-20 mA analog output
    iv. Binary Outputs – shall output the following:
        - 24 VAC Triac
    v. Configurable Outputs – shall be capable of the following:
        - 0-10 VDC analog output
        - 24 VAC Triac binary output
h. The XPM shall include troubleshooting LEDs to indicate the following conditions:
    i. Power – to indicate if the device is powered or not powered
    ii. Fault – to indicate if the device is in its default state, has no faults, has a device fault, is in startup or download mode, or has an SA Bus communication issue
    iii. SA/FC Bus – to indicate if bus communication is occurring and normal, is not occurring, or was occurring but has been lost and is waiting to rejoin
    iv. EOL – to indicate if the end of line termination is on or off.
i. Provide Johnson Controls XPM or approved equal as shown on plans.

4. Network Thermostat – Fan Coil and Zoning
    a. The network thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters, a pressure dependent VAV System, zoning type systems employing reheat including local hydronic reheat valves, RTU/heat pump with economizer or other similar equipment.
    b. The Networked Thermostat shall communicate over the FC Bus using BACnet Standard protocol SSPC-135 or Johnson Controls N2 protocol.
        i. Communications shall be selectable locally at thermostat through the display.
    c. The TEC shall be BTL listed/certified and carry the BTL Label.
        i. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
    d. The network thermostat shall include a 4.2 inch LED backlit touch screen

e. The network thermostat shall provide the flexibility to support any one of the following inputs:
    i. Integral indoor air temperature sensor.
    ii. Analog input for remote air temperature sensing
    iii. Universal input
    iv. Remote indoor air temperature sensor.
    v. Two configurable binary inputs
f. The network thermostat shall provide 4 digit passcode security.
g. The network thermostat shall employ nonvolatile EEPROM for all adjustable parameters.
h. The network thermostat shall have a temperature accuracy of ±0.9°F/±0.5°C at 70.0°F/21.0°C typical calibrated.
i. The network thermostat shall have a humidity accuracy of ±5% RH from 20 to 80% RH at 50 to 90°F (10 to 32°C.)
j. The network thermostat shall provide user equipment visibility from a mobile device
k. Provide Johnson Controls TEC or approved equal as indicated on plans.

5. Network Sensors
    a. The Network Sensors (NS) shall have the ability to monitor the following variables all within a single wall-mounted enclosure (no exceptions) as required by the systems sequence of operations:
        i. Zone Temperature
        ii. Zone Humidity
        iii. Zone Occupancy
        iv. Zone CO_2
    b. The NS shall transmit the information back to the controller on the SA Bus using BACnet Standard protocol SSPC-135.
    c. The NS shall be BTL listed/certified and carry the BTL Label.
        i. The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).
    d. The Network Zone Temperature Sensors shall include the following items:
        i. A backlit LCD to indicate the temperature, humidity and setpoint
        ii. Available in either surface mount, wall mount, or flush mount
        iii. Provide with screw terminals
    e. Provide Johnson Controls NS series or approved equal where indicated on plans.

2.8 System Tools

1. One software copy of each system tool shall be provided with the BMS
2. System Configuration Tool
    a. The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a Network Engine.
    b. The configuration tool shall provide an archive database for the configuration and application data.
    c. The configuration tool shall include the following features:
        i. Basic system navigation tree for connected networks

ii. Integration of Johnson Controls N1, LonWorks, and BACnet enabled devices

iii. Customized user navigation trees

iv. Point naming operating parameter setting

v. Graphic diagram configuration

vi. Alarm and event message routing

vii. Graphical logic connector tool for custom programming

viii. Downloading, uploading, and archiving databases

d. The configuration tool shall provide a site discovery feature to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:

i. BACnet Devices

ii. LonWorks devices

iii. Johnson Controls N2 Bus devices

e. A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.

i. The wireless connection shall allow the PC to access configuration tool through the web browser using the user interface.

ii. The wireless use of configuration tool shall be the same as a wired connection in every respect.

iii. The wireless connection shall use the Bluetooth Wireless Technology.

f. Provide Johnson Controls SCT or approved equal.

3. Controller Configuration Tool

a. As part of the single software tool environment including system and controller elements, the Controller Configuration Tool (CCT) shall be used to configure, simulate and commission equipment controllers (e.g. CGM, CVM, XPM, FAC, FEC, VMA, and IOM) and Network Control Engine controllers.

b. The CCT shall operate in distinct modes to facilitate efficiency at various steps in the steps leading to project completion as well as future upgrades and maintenance:

iv. The configuration mode allows users to select various mechanical and control logic options through selection trees for typical air handling, terminal unit, central plant, and VAV applications.

v. The simulation mode allows the user to review all application logic as if the device were operating in a connected systems environment.

vi. The commissioning mode allows users to validate all sensor and control point interfaces and to adjust key setpoints and setup parameters once the device is mounted and connected in an operational environment.

c. The configuration tool shall be capable of programming the Equipment Controllers.

i. The configuration tool shall provide the capability to configure, simulate, and commission the Equipment Controllers.

ii. The configuration tool shall allow the equipment controllers to be run in Simulation Mode to verify the applications.

iii. The configuration tool shall contain a library of standard applications to be used for configuration.

d. The CCT shall provide multiple options for downloading files to the controllers including direct wired, wireless and Ethernet pass thru as dictated by controller type and location.

e. Provide Johnson Controls CCT or approve equal.

4. Performance Verification Tool (PVT) Report or "AS-IS" Digital Time Capsule Report

a. The IAS Contractor shall provide a "time capsule" report of all "as is" existing software and hardware configurations, as well as hardware operating status, for comparison with the final "as built" system, and/or to return the system to the "As Is" status and conditions in the event of a catastrophic failure.

b. The AS-IS Digital Time Capsule Report shall include:

i. A complete and current Integrated Automation System site inventory including the following information at a minimum: a listing of all field and supervisory controllers with the following key attribute data; corresponding model numbers, firmware versions, available security updates, CPU and memory performance data, battery conditions, integrations, controlled equipment, and device and point counts.

ii. A complete, documented evaluation of system configuration and performance in the following categories: Security, Energy Performance and Savings, Reliability, Comfort and Health, and Standards.

- The Security evaluation shall include information about controllers that require security updates and conformance of user accounts to latest security rules and best practices.
- The Energy Performance and Savings evaluation shall identify opportunities through schedule and nightly setbacks, economizers, eliminating simultaneous heating and cooling, and adding variable speed drives to equipment.
- The Comfort and Health evaluation shall identify temperature, pressure, and carbon dioxide values that deviate from desired set points that could lead to occupant discomfort.
- The Reliability evaluation shall identify overridden control points, control points creating excessive alarms, and opportunities to adding control points and trends to further enable system functionality.
- The Standards evaluation shall identify conformance to published IAS manufacturer controller limits for point count, network performance and protocol standards.

c. The AS-IS Digital Time Capsule Report shall be submitted in writing, with a PDF copy on a portable thumb drive device.

2.I Computing Hardware and Software

1. General

a. Computing hardware, software and operating systems shall be provided at the revision level or model number as specified or at the latest release of the vendor if not specified.

b. In order to provide a consistent level of performance, all PCs shall be provided with Operating Systems and Processors by the manufacturer specified.

2. Application and Data Server

a. PC Hardware – The personal computer shall be configured as follows:

i. Memory – 8 GB

ii. CPU – Intel Dual Core processor. 2.8 GHz Clock Speed (minimum)

iii. Hard Drive – 240 GB free hard drive space after program installation

iv. Hard Drive Backup – DVD/RW or 500 GB portable back-up drive

v. Ports: (2) USB 3.0, VGA, HDMI 1920x1080 resolution, Ethernet – 10/100/1000

vi. User Interface:

- 101 key full size QWERTY Keyboard with number pad
- Two (2) Button LED mouse
- LED flat panel 24 in. monitor with wide screen full HD resolution

b. Software/Operating System Requirements

i. Windows 10 Pro or Windows 10 Enterprise Editions with Anniversary Update (version 1607) (64-bit)

ii. SQL 2014 Express SP3 (64-bit)

iii. Microsoft Office Professional

iv. BMS supplier-specific programs and files required for described functionality.

3. Extended Application and Data Server

a. PC Hardware – The personal computer(s) shall be configured as follows:

i. Memory – 16 GB (8 GB Minimum)

ii. CPU – Intel Quad Core processor. 3.2 GHz Clock Speed (minimum)

iii. Optical Media Drive – DVD-RW 16x

iv. Hard Drives – 2x 500GB configured as Raid 1 (mirroring) with write caching turned on

v. Hard Drive Backup – 1TB portable back-up drive or secure network backup provided by owner's IT department

vi. Ports: (2) USB 3.0, HDMI capable of Wide screen 1920x1080 resolution, Ethernet 10/100/1000

vii. User Interface:

- 101 key full size QWERTY Keyboard with number pad
- Two (2) Button LED mouse
- LED flat panel 24 in. monitor with wide screen full HD resolution

b. Software/Operating System Requirements

i. Windows Server 2012 (64-bit)

ii. SQL 2014 SP2 (64-bit)

iii. Microsoft Office Professional

iv. BMS supplier-specific programs and files required for described functionality

2.B Miscellaneous Devices

1. Local Control Panels

a. All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508A label listing compliance. Control panels shall be fully enclosed, with sub-panel, hinged door, and flush latch.

b. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.

c. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.

d. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.

e. All wiring shall be neatly installed in plastic trays or tie-wrapped.

f. Control panels for use in seismic areas shall be built in an approved facility and carry the appropriate label.

g. Except where otherwise noted, all standard and custom control panels shall be built in an ISO9002 certified facility.

2. Power Supplies

a. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.

b. Input: 120 VAC +10%, 60Hz

c. Output: 24 VDC

d. Line Regulation: +0.05% for 10% line change

e. Load Regulation: +0.05% for 50% load change

f. Ripple and Noise: 1 mV rms, 5 mV peak to peak

g. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.

h. A power disconnect switch shall be provided next to the power supply.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Design Professional for resolution before rough-in work is started.

B. The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Professional for resolution before rough-in work is started.

C. The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate-or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others-the contractor shall report these discrepancies to the and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

3.2 PROTECTION

A. The contractor shall protect all work and material from damage by his/her work or employees and shall be liable for all damage thus caused.

B. The contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The contractor shall protect any material that is not immediately installed. The contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

A. Site.

1. Where the mechanical work will be installed in close proximity to, or will interfere with, work of other trades, the .2 Contractor shall assist in working out space conditions to make a satisfactory adjustment.
2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

B. Test and Balance.

1. The contractor (if necessary) shall provide the T&B contractor with test and balance software and cable to interface to the control system for test and balance purposes.
2. The contractor shall provide training in the use of these tools.
3. The tools used during the test and balance process will be returned at the completion of the testing and balancing process.
4. If interfacing capability cannot be provided, the contractor will assist the T&B contractor for the entirety of the test and balance process.

C. Life Safety.

1. Duct smoke detectors required for air handler shutdown are provided by others. Interlock smoke detectors to air handlers for shutdown as specified in the Sequence of Operations.
2. Smoke dampers and actuators required for duct smoke isolation are provided by others. Interlock smoke dampers to air handlers as specified in the Sequence of Operations.
3. Fire and smoke dampers and actuators required for fire-rated walls are provided by others. Fire and smoke damper control is provided by others.

3.4 GENERAL WORKMANSHIP

A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e. horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Install equipment in readily accessible locations as defined by the National Electrical Code (NEC).

D. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.5 FIELD QUALITY CONTROL

A. All work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances as identified in Section (Codes and Standards).

B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

3.6 EXISTING EQUIPMENT

A. Existing Automate Logic Corporation equipment at this site shall be retained and reused to the extent

possible and practical, including existing advanced metering systems for electricity, water and natural gas.

3.7 WIRING

A. All control and interlock wiring shall comply with national and local electrical codes, and electrical specifications. Where the requirements of this section differ from other divisions of this specification, the requirements of this section shall take precedence.

B. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and electrical specification requirements.

C. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be subfused when required to meet Class 2 current limit.

D. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended application.

E. All wiring in mechanical, electrical, or service rooms - or where subject to mechanical damage - shall be installed in raceway at levels below 3 m (10ft).

F. Do not install Class 2 wiring in raceways containing Class 1 wiring. Boxes and panels containing high-voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).

G. Do not install wiring in raceway containing tubing.

H. Where Class 2 wiring is run exposed, wiring is to be run parallel along a surface or perpendicular to it and neatly tied at 3 m (10 ft) intervals.

I. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

J. All wire-to-device connections shall be made at a terminal block or terminal strip. All wire-to-wire connections shall be at a terminal block.

K. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

L. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, the contractor shall provide step-down transformers.

M. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

N. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations.

O. Size of raceway and size and type of wire shall be the responsibility of the contractor in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

P. Include one pull string in each raceway 2.5 cm (1 in.) or larger.

Q. Use color-coded conductors throughout with conductors of different colors.

R. Control and status relays are to be located in designated enclosures only. These enclosures include

packaged equipment control panel enclosures unless they also contain Class 1 starters.

S. Conceal all raceways except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g. steam pipes or flues).

T. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

U. Adhere to electrical specification requirements where raceway crosses building expansion joints.

V. Install insulated bushings on all raceway ends and openings to enclosures. Seal top end of vertical raceways.

W. The contractor shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.

X. Flexible metal raceways and liquid-tight flexible metal raceways shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal raceway less than ½ in. electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

Y. Raceway must be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations must be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

3.8 COMMUNICATION WIRING

A. The contractor shall adhere to the items listed in the "Wiring" article in Part 3.7 of the specification.

B. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

C. Do not install communication wiring in raceways and enclosures containing Class 1 or other Class 2 wiring.

D. Maximum pulling, tension, and bend radius for the cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

E. Contractor shall verify the integrity of the entire network following cable installation. Use appropriate test measures for each particular cable.

F. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to manufacturer's instructions.

G. All runs of communication wiring shall be unspliced length when that length is commercially available.

H. All communication wiring shall be labeled to indicate origination and destination data.

I. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

J. BACnet Arcnet or MS/TP communications wiring shall be installed in accordance with ASHRAE/ANSI Standard 135. This includes but is not limited to:

1. Arcnet

    a. The network shall use shielded, twisted-pair cable with characteristic impedance between

100 nominal. Distributed capacitance between conductors shall be less than 12.5 pF per foot (41 pF per meter.)

b. The maximum length of an Arcnet segment is 610 meters (2000 ft) with AWG 22 cable.
c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
d. An Arcnet network shall have no T connections.

2. MS/TP

a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)
b. The maximum length of an MS/TP segment is 1200 meters (4000 ft) with AWG 18 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485
c. The maximum number of nodes per segment shall be 32, as specified in the EIA 485 standard. Additional nodes may be accommodated by the use of repeaters.
d. An MS/TP EIA-485 network shall have no T connections.

3.9 INSTALLATION OF SENSORS

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by wall framing.

D. All wires attached to sensors shall be sealed in their raceways or in the wall to stop air transmitted from other areas from affecting sensor readings.

E. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

F. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 ft. of sensing element for each 1 ft^2 of coil area.

G. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 10 ft. downstream.

H. All pipe-mounted temperature sensors shall be installed in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.

I. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

J. Differential Air Static Pressure.

1. Supply Duct Static Pressure. Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.
2. Return Duct Static Pressure. Pipe high-pressure tap to duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor.
3. Building Static Pressure. Pipe the low-pressure port of the pressure sensor to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe the high-pressure

port to a location behind a thermostat cover.

4. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.
5. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.
6. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shut-off valves installed before the tee.

K. Smoke detectors, low limit temperature sensors, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

L. Install humidity sensors for duct mounted humidifiers at least 10 ft. downstream of the humidifier. Do not install filters between the humidifier and the sensor.

M. Install occupancy sensors in locations to allow for effective operation.

3.10 FLOW SWITCH INSTALLATION

A. Use correct paddle for pipe diameter.

B. Adjust flow switch according to manufacturer's instructions.

3.11 ACTUATORS

A. General. Mount and link control damper actuators according to manufacturer's instructions.

1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
3. Provide all mounting hardware and linkages for actuator installation.

B. Electric/ Electronic

1. Dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° travel available for tightening the damper seal. Actuators shall be mounted following manufacturer's recommendations.
2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.12 IDENTIFICATION OF HARDWARE AND WIRING

A. All wiring and cabling, including that within control panels, shall be labeled.

B. All pneumatic tubing shall be labeled at each end within 2 in. of termination with a descriptive identifier.

C. Permanently label or code each point of field terminal strips to show the instrument or item served.

D. Identify control panels with minimum ½ in. letters on laminated plastic nameplates.

E. Identify all other control components with labels.

F. Control System Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.

G. Identifiers shall match record documents.

3.13 CONTROLLERS

A. Provide a separate controller for each AHU, Hot Water system, Chilled Water system or other HVAC system. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller. Points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.

B. Building Controllers and Custom Application Controllers shall be selected to provide the required I/O point capacity required to monitor all of the hardware points listed in the Sequence of Operation.

3.14 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and trend logging

B. Point Naming. Name points as shown on the equipment points list provided with each sequence of operation. See Sequence of Operations. If character limitations or space restrictions make it advisable to shorten the name, the abbreviations given in the Sequence of Operations may be used. Where multiple points with the same name reside in the same controller, each point name may be customized with its associated Program Object number. For example, "Zone Temp 1" for Zone 1, "Zone Temp 2" for Zone 2.

C. Operator Interface.

1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as setpoints. As a minimum, show on each equipment graphic the input and output points and relevant calculated points as indicated on the applicable Points List in Section 23.
2. The contractor shall provide necessary labor to start up and troubleshoot all operator interface software and its functions as described in this section. This includes any operating system software, the operator interface database, and any third-party software installation and integration required for successful operation of the operator interface.

3.15 CONTROL SYSTEM CHECKOUT AND TESTING

A. Startup Testing. All testing listed in this article shall be performed by the contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Client Agency's representative is notified of the system demonstration

1. The contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures according to manufacturers' recommendations.

4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The contractor shall check all control valves and automatic dampers to ensure proper action and closure. The contractor shall make any necessary adjustments to valve stem and damper blade travel.
6. Verify that the system operation adheres to the sequences of operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops.
7. Alarms and Interlocks:

    a. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.
    b. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
    c. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.16 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration.

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.
2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process and as specified in the "Control System Checkout and Testing" article in Part 3 of this specification. The Professional will be present to observe and review these tests. The engineer shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1, "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The contractor shall provide at least two persons equipped with two-way communication and shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1, "System Performance."
7. Demonstrate compliance with sequences of operation through all modes of operation.
8. Demonstrate complete operation of operator interface.
9. Additionally, the following items shall be demonstrated:

    a. DDC loop response. The contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
    b. Optimum start/stop. The contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

c. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the Design Professional. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

10. Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests

B. Acceptance.

1. All tests described in this specification shall have been performed to the satisfaction of both the Professional and Client Agency prior to the acceptance of the control system as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the contractor may be exempt from the completion requirements if stated as such in writing by the Professional. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1, "Submittals."

3.17 CLEANING

A. The contractor shall clean up all debris resulting from his/her activities daily. The contractor shall remove all cartons, containers, crates, etc., under his/her control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.

B. At the completion of work in any area, the contractor shall clean all work, equipment, etc., keeping it free from dust, dirt, and debris, etc.

3.18 TRAINING

A. Provide (8) hours of onsite training for a designated staff of Client Agency's representatives.

3.19 START-UP AND CHECKOUT PROCEDURES

A. Start up, check out, and test all hardware and software and verify communication between all components.

1. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
2. Verify that all analog and binary input/output points read properly.
3. Verify alarms and interlocks.
4. Verify operation of the integrated system.

END OF SECTION 230923

SECTION 232113.33

GROUND-LOOP HEAT-PUMP PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes piping for vertical, direct-buried, ground-loop, heat-pump systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Pipe and fittings.
2. Joining method and equipment.
3. Ethyl Alcohol solution.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Borehole backfilling and drilling operations reports.

C. Dimensioned site layout.

D. Startup performance results.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS

A. HDPE Pipe: ASTM D 3035.

B. Molded PE Fittings: ASTM D 2683 or ASTM D 3261, ASTM F 1055 PE resin, socket, butt-fusion or electro-fusion type, made to match PE pipe dimensions and class.

C. U-Bend Assembly: Factory fabricated with embossed depth stamp every 36 inches from U-bend.

D. Ground-Loop, Heat-Pump Piping Minimum Working Pressure: 200 psig.

E. Ground-Loop, Heat-Pump Piping Operating Temperature: Between 23 and 115 deg F.

2.2 BOREHOLE BACKFILL

A. Seal Material: Bentonite clay with thermal conductivity greater than 1.07 Btu/h x sq. ft. x deg F according to ASTM D 5334.

B. Permeability: Not more than 1 nm/s according to ASTM D 5084

2.3 ANTIFREEZE SOLUTION

A. Ethyl Alcohol: Minimum 99 percent ethyl alcohol with corrosion inhibitors and environmental stabilizer additives to be mixed with water to protect piping circuit and connected equipment from physical damage caused by freezing or corrosion.

B. Final mixture content shall be a 50% ethyl alcohol solution.

C. Quantity: Sufficient solution for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

D. Dilution Water: Chloride content shall be less than 25 ppm, sulfate content less than 25 ppm, and hardness less than 100 ppm.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, warning tape, and backfilling are specified in Section 312000 "Earth Moving."

3.2 VERTICAL PIPING INSTALLATION

A. Install HDPE piping in boreholes according to ASTM D 2774 or ASTM F 645.

1. Clean HDPE pipe and fittings and make heat-fusion joints according to ASTM D 2657. Minimize number of joints.

B. Purge, flush, and pressure test piping before backfilling boreholes.

C. Completely fill the borehole from bottom to top with backfill material.

D. Install the header piping 48” deep and install the horizontal piping from the header to the boreholes.

E. Extend the horizontal piping and connect to ground-loop heat-pump piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Refer to the drawings for piping arrangement and additional installation requirements.

F. Backfill the horizontal piping and header trenches.

G. Fill the entire piping loop with antifreeze solution.

H. Maintain records of backfilling on-site.

I. Mark borehole locations, header pipes, and horizontal runs with metallic locator tape as specified in Section 230553 "Mechanical Identification for HVAC Piping and Equipment."

3.3 ANTIFREEZE SOLUTION FILL

A. Fill system with required quantity of ethyl alcohol and water to provide minus 10 deg F freezing temperature.

B. Test dilute solution using gas chromatography to verity concentration of ethyl alcohol, and forward report to Owner.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

3.5 FIELD QUALITY CONTROL

A. Piping Tests: Fill piping 24 hours before testing and apply test pressure to stabilize piping. Use potable water only.

B. Hydrostatic Tests: Test at not less than 1-1/2 times the pipe working-pressure rating or 300 percent of system design pressure, whichever is more.

1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 30 minutes. Slowly increase to next test pressure increment and hold for 30 minutes. After testing at maximum test pressure, reduce pressure to 30 psig. Hold for 90 minutes, and measure pressure at 30-minute intervals. Repair leaks and retest until no leaks exist.
2. Maintain a minimum pipe velocity of 24 in./s for a minimum of 15 minutes to remove all air.

C. Prepare test and inspection reports.

END OF SECTION 232113.33

SECTION 232116

HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.
4. Connectors.

B. Related Requirements:
1. Section 230523. " GENERAL-DUTY VALVES FOR HVAC PIPING " for specification and installation requirements for valves common to most piping systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 HYDRONIC SPECIALTY VALVES

A. Plastic Ball Valves:
1. Body: One-, two-, or three-piece CPVC or PVC to match piping.
2. Ball: Full-port CPVC or PVC to match piping.
3. Seats: PTFE.
4. Seals: EPDM.
5. End Connections: Socket, union, or flanged.
6. Handle Style: Tee shape.
7. CWP Rating: Equal to piping service.
8. Maximum Operating Temperature: Equal to piping service.
9. Comply with MSS SP-122.

B. Plastic Butterfly Valves:
1. Body: PVC or CPVC to match piping wafer type for installation between flanges.
2. Disc: EPDM-coated steel.
3. Seats: PTFE.
4. Handle Style: Locking lever.
5. CWP Rating: Equal to piping service.
6. Maximum Operating Temperature: Equal to piping service.

C. Plastic Check Valves:
1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

D. Bronze, Calibrated-Orifice, Balancing Valves:
1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.

6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

E. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Stem Seals: EPDM O-rings.
4. Disc: Glass and carbon-filled PTFE.
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig .
7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:
1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

C. Expansion Tanks:
1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
3. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.

4. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.

D. Bladder-Type Expansion Tanks:
1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
2. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. Tangential-Type Air Separators:
1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

2.3 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig.

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: [40] [60]-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

2.4 CONNECTORS

A. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

B. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main and where indicated on the drawings.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

E. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 232123

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One> mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.

B. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
5. Pump Bearings: Permanently lubricated ball bearings.

C. Motor: Single speed and rigidly mounted to pump casing.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Enclosure: Open, drip proof
b. Enclosure Materials: Cast iron
c. Motor Bearings: Permanently lubricated ball bearings.

2.2 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

B. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: Stainless steel.
4. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.

C. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.

D. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

E. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

F. Motor: Single speed, secured to mounting frame, with adjustable alignment.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

    a. Enclosure: Open, dripproof or Explosion proof as indicated on the drawings.
    b. Enclosure Materials: Cast iron.
    c. Motor Bearings: Permanently lubricated ball bearings.
    d. Unusual Service Conditions:

2.3 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. 175-psig (1204-kPa)] pressure rating, cast iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.
2. 175-psig [pressure rating, cast-iron body, pump-discharge fitting.
3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
4. Brass gage ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

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

3.2 PUMP INSTALLATION

A. Comply with HI 1.4 and HI 2.4 .

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

E. Equipment Mounting:

1. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete." and Section 033053 "Miscellaneous Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

F. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps.

1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install triple-duty valve on discharge side of pumps.

F. Install Y-type strainer, suction diffuser and shutoff valve on suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.
b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232300
REFRIGERANT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.

1. Include pressure drop, based on manufacturer's test data, for the following:

a. Electronic expansion valves.
b. Solenoid valves.
c. Filter dryers.
d. Strainers.
e. Pressure-regulating valves.

B. Shop Drawings:

1. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
2. Show interface and spatial relationships between piping and equipment.
3. Shop Drawing Scale: 1/4 inch equals 1 foot

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 2010 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-448a:

1. Suction Lines for Air-Conditioning Applications: 115 psig (793 kPa).
2. Suction Lines for Heat-Pump Applications: 225 psig (1551 kPa).
3. Hot-Gas and Liquid Lines: 225 psig (1551 kPa).

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8/A5.8M.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Working Pressure Rating: Factory test at minimum 500 psig
5. Maximum Operating Temperature: 250 deg F

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as selected in piping application articles.

B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.

C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.

D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

E. Flanged Unions:

1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3 Apply rust-resistant finish at factory.
2. Gasket: Fiber asbestos free.
3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
6. Pressure Rating: Factory test at minimum 400 psig
7. Maximum Operating Temperature: 330 deg F

F. Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket.
2. End Connections:

    a. NPS 2 and Smaller: With threaded-end connections.
    b. NPS 2-1/2 and Larger: With flanged-end connections.

3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig
5. Maximum Operating Temperature: 250 deg F

2.4 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F .

B. Packed-Angle Valves:

1.
2. Body and Bonnet: Forged brass or cast bronze.
3. Packing: Molded stem, back seating, and replaceable under pressure.
4. Operator: Rising stem.
5. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
6. Seal Cap: Forged-brass or valox hex cap.
7. End Connections: Socket, union, threaded, or flanged.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

C. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
3. Piston: Removable polytetrafluoroethylene seat.
4. Closing Spring: Stainless steel.
5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
6. End Connections: Socket, union, threaded, or flanged.
7. Maximum Opening Pressure: 0.50 psi.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

D. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
2. Core: Removable ball-type check valve with stainless-steel spring.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Copper spring.
5. Working Pressure Rating: 500 psig.

E. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).
1. Body and Bonnet: Plated steel.
2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
3. Seat: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and [24] [115] [208]-V ac coil.
6. Working Pressure Rating: 400 psig.
7. Maximum Operating Temperature: 240 deg F.

F. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
   2. Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Working Pressure Rating: 400 psig.
   6. Maximum Operating Temperature: 240 deg F.

G. Thermostatic Expansion Valves: Comply with AHRI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
   2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Packing and Gaskets: Non-asbestos.
   4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
   5. Suction Temperature: [40 deg F
   6. Superheat: adjustable.
   7. Reverse-flow option (for heat-pump applications).
   8. End Connections: Socket, flare, or threaded union.
   9. Working Pressure Rating: [700 psig.

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
   1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
   2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Packing and Gaskets: Non-asbestos.
   4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   5. Seat: Polytetrafluoroethylene.
   6. Equalizer: Internal.
   7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter and [24] [115] [208]-V ac coil.
   8. End Connections: Socket.
   9. Set Pressure: psig.
   10. Throttling Range: Maximum 5 psig.
   11. Working Pressure Rating: 500 psig.
   12. Maximum Operating Temperature: 240 deg F.

I. Straight-Type Strainers:
   1. Body: Welded steel with corrosion-resistant coating.
   2. Screen: 100-mesh stainless steel.
   3. End Connections: Socket or flare.
   4. Working Pressure Rating: 500 psig.
   5. Maximum Operating Temperature: 275 deg F .

J. Angle-Type Strainers:
   1. Body: Forged brass or cast bronze.
   2. Drain Plug: Brass hex plug.
   3. Screen: 100-mesh monel.
   4. End Connections: Socket or flare.
   5. Working Pressure Rating: 500 psig.
   6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in parts per million (ppm).
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with AHRI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated [alumina] [charcoal].
4. End Connections: Socket.
5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
6. Maximum Pressure Loss: [2 psig .
7. Rated Flow: tons
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F

M. Receivers: Comply with AHRI 495.
1. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 deg F (135 deg C).

N. Liquid Accumulators: Comply with AHRI 495.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or threaded.
4. Working Pressure Rating: 500 psig (3450 kPa).
5. Maximum Operating Temperature: 275 deg F (135 deg C).

2.5 REFRIGERANTS

A. ASHRAE 34, R-448a:.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-407C

A. Suction Lines NPS 4 and Smaller NPS 2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR Type L, drawn-temper tubing and wrought-copper fittings with [brazed] [or] [soldered] joints.

B. Safety-Relief-Valve Discharge Piping: Schedule 40, black-steel and wrought-steel fittings with welded joints.

C. Safety-Relief-Valve Discharge Piping: Copper, [Type ACR] [Type K (A)] [Type L (B)], drawn-temper tubing and wrought-copper fittings with soldered joints.

D. Safety-Relief-Valve Discharge Piping:

1. [NPS 1 (DN 25) and Smaller] <Insert pipe size range>: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with [brazed] [or] [soldered] joints.
2. [NPS 1 (DN 25) and Smaller] <Insert pipe size range>: Copper, [Type ACR] [Type L (B)], drawn-temper tubing and wrought-copper fittings with [brazed] [or] [soldered] joints.
3. [NPS 1-1/4 to NPS 2 (DN 32 to DN 50)] <Insert pipe size range>: Copper, Type K (A), annealed- or drawn-temper tubing and wrought-copper fittings with [brazed] [or] [soldered] joints.
4. [NPS 4 (DN 100)] <Insert pipe size>: Copper, [Type ACR] [Type K (A)] [Type L (B)], drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

A. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

B. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

C. Install a full-size, three-valve bypass around filter dryers.

D. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

E. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.
2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

F. Install safety relief valves where required by 2010 ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

G. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

H. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for the device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot-gas bypass valves.
4. Compressor.

I. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

J. Install receivers sized to accommodate pump-down charge.

K. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

A. 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 Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. 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.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Section 083113 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:

1. Shot blast the interior of piping.
2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

S. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

D. Threaded Joints: Thread steel 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 to restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.5 HANGERS AND SUPPORTS

A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:

1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod, 1/4 inch (6.4 mm).

2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod, 1/4 inch (6.4 mm).
3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod, 1/4 inch (6.4 mm).
4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod, 3/8 inch (9.5 mm).
5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod, 3/8 inch (9.5 mm).
6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod, 3/8 inch (9.5 mm).
7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod, 3/8 inch (9.5 mm).
8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod, 3/8 inch (9.5 mm).
9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod, 1/2 inch (13 mm).

D. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 (DN 50): Maximum span, 10 feet (3 m); minimum rod, 3/8 inch (9.5 mm).
2. NPS 2-1/2 (DN 65): Maximum span, 11 feet (3.4 m); minimum rod, 3/8 inch (9.5 mm).
3. NPS 3 (DN 80): Maximum span, 12 feet (3.7 m); minimum rod, 3/8 inch (9.5 mm).
4. NPS 4 (DN 100): Maximum span, 14 feet (4.3 m); minimum rod, 1/2 inch (13 mm).

E. Support multifloor vertical runs at least at each floor.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

B. Prepare test and inspection reports.

3.7 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.8 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION 232300

SECTION 232513

WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following water treatment for closed-loop hydronic systems:

1. Manual chemical-feed equipment.
2. Cheicals.

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

B. RO: Reverse osmosis.

C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. Chemical test equipment.
3. Chemical material safety data sheets.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to hydronic systems.

1. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.

B. Field quality-control reports.

C. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
2. Water Analysis: Illustrate water quality available at Project site.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including condenser water, shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within 100 to 200 ppm.
4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TSS: Maintain a maximum value of 10 ppm.
7. Ammonia: Maintain a maximum value of 20 ppm.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
9. Microbiological Limits:

a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 2 gal..
2. Minimum Working Pressure: 125 psig.

2.3 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Bypass Feeders: Install in closed hydronic systems, including condenser water, and equipped with the following:

1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
2. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
3. Install a swing check on the inlet after the isolation valve.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties."

C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

D. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in makeup-water connections to potable-water systems.

E. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

B. Equipment will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

D. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.

E. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.
2. Acidity and Alkalinity: ASTM D 1067.
3. Iron: ASTM D 1068.
4. Water Hardness: ASTM D 1126.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION 232513

SECTION 233113

METAL DUCTS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Submittals: Steel Certificates: For each type of product indicated.

1. Exhaust Duct.

C. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Fittings.
4. Reinforcement and spacing.
5. Seam and joint construction.
6. Equipment installation based on equipment being used on Project.
7. Hangers and supports, including methods for duct and building attachment and vibration isolation.
8. Testing, Balancing and Adjusting Reports.
9. Steel Certifications.

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable

sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 or G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width:3 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

I. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

J. Restraint Cables: ASTM A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

K. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

L. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
4. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
5. Unconditioned Space, Exhaust Ducts: Seal Class C.
6. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
7. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
8. Conditioned Space, Exhaust Ducts: Seal Class B.

3.3 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Make-Up Air Units:

a. Pressure Class: Positive 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.

B. Exhaust Ducts:

1. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
b. Concealed: Carbon Steel Sheet.
c. Welded seams and joints.
d. Pressure Class: Positive or negative 2-inch wg.
e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
f. SMACNA Leakage Class: 3.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 DUCT CLEANING

A. Clean new duct system before testing, adjusting, and balancing.

3.7 START UP

A. Air Balance: Contractor shall test and adjust fans to Toilet/Shower room exhaust fans for proper rotation and working order. Balance and Adjust outside air handler supply ductwork for required CFM to each supply diffuser and grille. Provide a balance report upon completion.

3.8 DUCT SCHEDULE

A. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive and Negative: 2-inch wg .
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.

B. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

    a. Pressure Class: Negative 2-inch wg .
    b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.

C. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

    a. Velocity 1000 fpm or Lower:

        1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
        2) Mitered Type RE 4 without vanes.

    b. Velocity 1000 to 1500 fpm:

        1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
        2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

D. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

END OF SECTION

SECTION 233423

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Downblast Centrifugal ventilators.
2. Direct Drive Centrifugal ventilators.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.
3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Operation and maintenance data.

D. Steel Certifications.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

PART 2 - PRODUCTS

2.1 DOWNBLAST CENTRIFUGAL VENTILATORS

Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Greenheck.
2. Hartzell Fan Incorporated.
3. Loren Cook Company.
4. Or approved equal.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; aluminum base with venturi inlet cone.

1. Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels:
1. Aluminum hub and wheel with backward-inclined blades.

D. Accessories:
1. Disconnect Switch: Non-fusible type, with thermal-overload protection mounted inside or outside fan housing per schedule, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers:
   a. Counterbalanced, parallel-blade, back draft dampers mounted in curb base; factory set to close when fan stops.

E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Built-in raised cant and mounting flange.
2. Overall Height: 16 inches
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.

F. Capacities and Characteristics: See Drawing Schedule for Capacities and Characteristics

2.2 IN-LINE CENTRIFUGAL FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Greenheck Fan Corporation.
   2. Hartzell Fan Incorporated.
   3. Loren Cook Company.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing[; with wheel, inlet cone, and motor on swing-out service door].

D. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

E. Accessories:

   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   3. Companion Flanges: For inlet and outlet duct connections.
   4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
   5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
   6. Vibration Isolators:
      a. Type: Elastomeric hangers.
      b. Static Deflection: 1 inch .
   7. Spark Arrestance Class: C.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings.

END OF SECTION

SECTION 236514.17

CLOSED-CIRCUIT, INDUCED-DRAFT, COMBINED-FLOW COOLING TOWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes factory-assembled, closed-circuit, induced-draft, combined-flow cooling towers.

1.3 DEFINITIONS

A. SCCR: Short-circuit current rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, pressure drop, fan performance data, rating at selected points indicated, and furnished specialties and accessories.
2. Maximum flow rate.
3. Minimum flow rate.
4. Pressure required at cooling tower supply piping connections.
5. Pressure required at collection basin sweeper supply piping connections.
6. Drift loss as percent of design flow rate.
7. Sound:

    a. Sound pressure levels for operation with fan off, fan at minimum speed, and design speed. If sound requirements are indicated at a specific distance, submit performance using same distance for comparative analysis.
    b. Sound power levels in eight octave bands for operation with fans off, fans at minimum speed, and design speed.

8. Performance curves for the following:

    a. Varying entering-water temperatures from design to minimum in one-degree temperature increments.
    b. Varying ambient wet-bulb temperatures from design to minimum in one-degree temperature increments.

c. Varying water flow rates from design to minimum in increments of 10 percent of flow rate difference between design and minimum flow rates.
d. Varying fan operation from design to minimum speed in 5 percent speed increments, and with fan off.

9. Fan airflow at design conditions, brake horsepower, and drive losses (indicated in horsepower and percent of brake horsepower).
10. Fan motor electrical characteristics including, but not limited to, speed, voltage, phase, hertz, amperage, efficiency, and power factor at 100, 75, 50, and 25 percent of nameplate horsepower.
11. Electrical power requirements for each cooling tower component requiring power.

B. Shop Drawings:

1. Manufacturer's drawings of assembled cooling towers, control panels, sections, and elevations.
2. Assembled unit dimensions.
3. Diagram showing each separate piece requiring field assembly.
4. Shipped sub-assembly dimensions and weights for field assembly.
5. Assembled unit weight without water.
6. Operating weight and load distribution.
7. Unit vibration isolation.
8. Required clearances for maintenance and operation.
9. Sizes and dimensioned locations of piping and wiring connections.
10. Diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field Test Reports: Include startup service reports.

B. Source quality-control reports.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each cooling tower to include in emergency, operation, and maintenance manuals.

B. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Tool Kit:

1. A tool kit specially designed by cooling tower manufacturer for use in servicing cooling tower(s) furnished.
2. Special tools required to service components not readily available to Owner service personnel in performing routine maintenance.
3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Cooling Tower Tool Kit." Text size shall be at least 1 inch high.
4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 1/2 inch high.

B. Touchup Coating: 32-oz. container of paint coating used. Label outside of container with detailed description of coating to allow for procurement of a matching coating in the future.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by CTI.

B. CTI Certification: Cooling tower thermal performance according to CTI STD 201RS.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Coordinate requirements for multi-piece assembly for shipment. Limit the number of separate pieces for field installation to as few as possible.

B. If factory assembly of multiple pieces is required for testing or other reasons, disassemble cooling tower into major assemblies as required by installation before packaging for shipment.

1. Clearly label each separate package with a unique designation and include with assembly instructions for each complete cooling tower.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace the following components of cooling towers that fail in materials or workmanship within specified warranty period:

1. All components of cooling tower.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Nimbus – Advanced Process Cooling
2. Frigel – North America
3. Chem-Aqua – an NCH Company

2.2 PERFORMANCE REQUIREMENTS

A. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Vibration:

1. Rotating assemblies shall be dynamically balanced to achieve a balance level of "good" while complying with industry standard requirements for cooling towers.
2. Critical speed shall be at least 115 percent of design speed.

2.3 DESIGN ARRANGEMENT

2.4 CASING AND FRAME

A. Casing Material: Polymer-coated galvanized steel Some manufacturers use different materials for casing and frame on some products. Confirm product availability with listed manufacturers if retaining "materials to match casing" option in "Frame Material" Paragraph below.

B. Frame Material: polymer-coated galvanized steel

C. Hardware: Galvanized steel.

D. Joints and Seams: Sealed watertight.

E. Welded Connections: Sealed watertight.

2.5 DRIFT ELIMINATORS

A. Material: PVC with maximum flame-spread index of 5 according to ASTM E 84.

B. UV Treatment: Inhibitors to protect against damage caused by UV radiation.

C. Arrangement: Multiple, easily removable sections.

2.6 AIR INLET

A. Air-Intake Louvers:

1. Material: PVC
2. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
3. Multiple, easily removable sections arranged to uniformly direct air into cooling tower, to minimize air resistance, to block direct sunlight, and to prevent water from splashing out of tower during all modes of operation including operation with fans off.

B. Removable Air-Intake Screens:

1. Polymer-coated, galvanized-steel wire mesh with openings of size sufficient to not restrict airflow or impact performance.
2. Segmented into manageable individual sections arranged to facilitate independent removal of each section without disturbing adjoining sections.

2.7 FAN AND DRIVE ASSEMBLY

A. Axial Fan: Balanced at the factory after assembly.

1. Blade Material: FRP.
2. Hub Material: FRP
3. Blade Pitch: Field adjustable.
4. Fan Shaft: Stainless steel.
5. Fan Shaft Bearings: Self-aligning ball or roller bearings with moisture-proof seals and premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F. Bearings designed for an L-10 life of 100,000 hours.
6. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
7. Automatic Bearing Greasing System:

    a. Manufacturer-designed system to provide an as-needed supply of new grease to bearings while reducing the need for periodic bearing maintenance and associated greasing problems.
    b. Easily replaceable storage container filled with recommended grease and located in an easily accessible location on cooling tower exterior. Container capacity of sufficient size to provide grease for one year.

B. Direct Drive: Fan hub directly connected, and properly secured, to motor shaft.

C. Fan Motor:

1. Comply with NEMA MG 1 unless otherwise indicated.
2. Description: NEMA MG 1, Design B, as required to comply with capacity and torque characteristics; medium induction motor.
3. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.
4. Motor Enclosure: Totally enclosed.
5. Rotor: Random-wound, squirrel cage.
6. Energy Efficiency: Comply with ASHRAE/IES 90.1.
7. Service Factor: 1.15.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.
10. Variable-Speed Motors: Inverter-duty rated per NEMA MG 1, Section IV, "Performance Standard Applying to All Machines," Part 31, "Definite-Purpose, Inverter-Fed, Polyphase Motors."
11. Motor Location: Mounted outside of cooling tower casing and cooling tower discharge airstream.
12. Severe-Duty Rating:

    a. Rotor and stator protected with corrosion-inhibiting epoxy resin.

b. Double-shielded, vacuum-degassed bearings lubricated with premium, moisture-resistant grease suitable for temperatures between minus 20 and plus 300 deg F.
c. Internal Heater: Automatically energized when motor is de-energized.
d. Complying with IEEE 841.

13. Motor Shaft Grounding: Motors shall be controlled through variable-frequency controllers with shaft grounding system to protect motor bearings from induced voltage. Drag on motor shaft due to shaft ground system shall be less than 0.5 percent of motor nameplate horsepower.

D. Hardware: Galvanized or stainless steel.

2.8 AIR DISCHARGE

A. Fan Discharge Stack:

1. Manufacturer's standard low-profile design.
2. Material: Material to match casing.
3. Stack Termination: Wire-mesh, polymer-coated, galvanized-steel or stainless-steel screens; segmented into multiple removable pie sections and complying with OSHA regulations.

B. Hardware: Galvanized or stainless steel.

2.9 ELECTRICAL POWER

A. Factory Furnish for Field Installation: A variable-frequency controller for each fan motor.

B. Factory Install: A variable-frequency controller for each fan motor.

1. Locate in a convenient and field-accessible location within sight of motor.
2. Installation shall comply with NFPA 70.
3. Wire, Conduit, and Enclosures:

a. Minimum Conduit Size: 0.75 inch.
b. Materials: Corrosion resistant and constructed of stainless steel or PVC coated steel.
c. Motor Termination: Liquidtight conduit, not to exceed 36 inches long.
d. Supports: Support conduits, boxes, and enclosures using corrosion-resistant fastening hardware constructed of stainless steel.
e. Wire:

1) Copper, rated for 600-V, solid wire for size No. 10 AWG and smaller and stranded wire for larger sizes.
2) Minimum Wire Size: No. 12 AWG.
3) Each circuit shall have a ground wire.
4) Install wire in conduit.

f. Boxes, Condulets, and Enclosures: NEMA 250, Type 3R.

C. Disconnect Switches:

1. Specification Grade; "Heavy Duty Type"; "quick-make," "quick-break" construction.
2. Three pole, fused.
3. 600-V rated.
4. Minimum short-circuit current rating (SCCR) shall be as required by electrical power distribution system, but not less than 65,000 A.
5. Enclosure: NEMA 250, Type 3R.
6. Operating handle shall be of box-mounted type that directly drives switch mechanism.
7. Disconnect switch shall use a flange-operated visible blade that is close coupled to a vertical-lift-type handle that achieves a positive visible indication of disconnect with cover open or closed.
8. Disconnect switch shall have a defeatable, front-accessible, mechanical interlock to prevent opening of cover when switch is in "ON" position, and to prevent turning switch "ON" when the door is open.
9. Include a solid neutral as required by authorities having jurisdiction.
10. Include a ground lug for ground wire termination.
11. Operating handle shall be lockable in open position.
12. Horsepower rated.
13. Feed through or double lugged.

D. Motor Controllers:

1. NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller.
2. Configured for control of single- or multispeed motors as indicated.
3. Enclosure: NEMA 250, Type 3R, with hinged full-front access door with lock and key.
4. Externally Operated[, Door-Interlocked] Disconnect: Fused disconnect switch with lockable handle.
5. SCCR shall be as required by electrical power distribution system, but not less than 65,000 A.
6. Hand-Off-Auto Switch: Mounted on face of enclosure.
7. Push-to-Test Run Status Pilot Lights: NEMA ICS 2, heavy-duty type.
8. Control Relays: Time-delay relays.
9. Phase-Failure, Phase-Reversal, Undervoltage Relays: Solid-state sensing circuit with adjustable undervoltage setting and isolated output contacts for hardwired connection.
10. Elapsed-Time Meters: Numerical readout in hours on face of enclosure.
11. Number-of-Starts Counter: Numerical readout on face of enclosure.

E. Variable-Frequency Controllers:

1. Description: NEMA ICS 2; arranged to achieve motor variable speed by adjusting output voltage and frequency.
2. Enclosure: Unit mounted, NEMA 250, Type 3R with hinged full-front access door with lock and key.
3. Externally Operated Disconnect: Fused disconnect switch with lockable handle.
4. Minimum SCCR: As required by electrical power distribution system, but not less than 65,000 A.
5. Technology: Pulse-width-modulated (PWM) output with insulated gate bipolar transistors (IGBT); suitable for variable torque loads.
6. Controller shall consist of a rectifier converter section, a digital/analog driver regulator section, and an inverter output section.

7. Output Rating: Three phase; with voltage proportional to frequency throughout voltage range.
8. Output signal shall be programmed to not cause mechanical vibration issues with fan drive assembly.
9. Operating Requirements:

    a. Input AC Voltage Tolerance: 10 percent.
    b. Input frequency tolerance of 60 Hz, plus or minus 2 Hz.
    c. Capable of driving full motor load, without derating.
    d. Minimum Efficiency: 96 percent at 60 Hz, full load.
    e. Minimum Displacement Primary-Side Power Factor: 95 percent.
    f. Overload Capability: 1.05 times the full-load current for 7 seconds.
    g. Starting Torque: As required by fan and motor drive assembly.
    h. Speed Regulation: 1 percent.
    i. Speed Range: 10:1 speed range.
    j. To avoid equipment resonant vibrations, include critical speed lockout circuitry to allow bands of operating frequency at which controller shall not operate continuously.
    k. Capable of being restarted into a motor coasting in either the forward or reverse direction without tripping.

10. Controller Adjustability Capabilities: Minimum and maximum output frequency, acceleration and deceleration, and current limit.
11. Self-Protection and Reliability Features: Subjecting the controller to any of the following conditions shall not result in component failure or the need for replacement:

    a. Overtemperature.
    b. Short circuit at controller output.
    c. Ground fault at controller output. Variable-frequency controller shall be able to start a grounded motor.
    d. Open circuit at controller output.
    e. Input undervoltage.
    f. Input overvoltage.
    g. Loss of input phase.
    h. Reverse phase.
    i. AC line switching transients.
    j. Instantaneous overload, line to line or line to ground.
    k. Sustained overload exceeding 100 percent of controller rated current.
    l. Starting a rotating motor.

12. Motor Protection: Controller shall protect motor against overvoltage and undervoltage, phase loss, reverse phase, overcurrent, overtemperature, and ground fault.
13. Automatic Reset and Restart:

    a. Capable of multiple restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction.
    b. Capable of automatic restart on phase-loss and overvoltage and undervoltage trips.

14. Visual Indication: On face of controller; indicating the following conditions:

    a. Power on.

b. Run.
c. Overcurrent and overvoltage.
d. Motor speed (percent).
e. Various faults with alarm status.
f. Input kilovolt amperes.
g. Power factor.
h. Input kilowatts and kilowatt-hours.
i. Three-phase input and output voltage.
j. Three-phase input and output current.
k. Output frequency.
l. Elapsed operating time (hours).
m. Diagnostic and service parameters.

15. Operator Interface: Start-stop and auto-manual selector with manual-speed-control potentiometer.
16. Control Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4 to 20 mA) and four programmable digital inputs.
17. Bypass Controller:

    a. Integrated NEMA ICS 2, Class A, full-voltage, non-reversing, motor-rated controller to operate fan motor if variable-frequency controller is not operational.
    b. Configure power supply to bypass controller and variable-frequency controller to completely isolate power to variable-frequency controller while operating fan motor through bypass controller for safe servicing of variable-frequency controller.
    c. Include "Bypass/VFC" manual selector switch on face of enclosure to provide for local operator control of preferred controller.
    d. Include fail-safe control logic to automatically transfer fan motor operation from failed variable-frequency controller to bypass controller.
    e. Install bypass controller in same enclosure as variable-frequency controller.

2.10 CONTROLS

A. Vibration Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4.
2. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point in a range of 0 to 1 g and frequency range of 0 to 3000 cycles per minute. Cooling tower manufacturer shall recommend switch set point for proper operation and protection.
3. Switch shall have manual-reset button with hardwired connection to fan motor electrical circuit.
4. Switch shall have field connection for hardwired connection to control system.
5. Switch shall, on sensing excessive vibration, signal an alarm for connection to control system and shut down the fan.

B. Vibration Transmitter with Switch: For each fan drive.

1. Enclosure: NEMA 250, Type 4X.
2. Display: Local display of measured value, power, and alarm.
3. Vibration Detection: Sensor with a field-adjustable, acceleration-sensitivity set point.

a. Cooling tower manufacturer shall select range that is suitable for cooling tower provided and recommend switch set point for proper operation and protection.

4. Transmitter: Continuous vibration level indication through a 4- to 20-mA signal for connection to control system.
5. Switch:

   a. Relay and switch with manual-reset button for field connection to control system and hardwired connection to fan motor electrical circuit.
   b. Switch shall, on sensing excessive vibration, signal an alarm to control system and shut down the fan.

6. Mounting: Locate out of cooling tower discharge airstream and mount in a location that is accessible and where display is easily viewable.
7. Field Electrical Connection Requirements: 120 V, single phase, 60 Hz.

C. Control Package:

1. Provide BACnet interface with BAS control system for monitoring of points.
2. Factory installed and wired, and functionally tested at factory before shipment.
3. NEMA 250, Type 3R enclosure with removable internally mount backplate.
4. Control-circuit transformer with primary and secondary side fuses.
5. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment.
6. Microprocessor-based controller for automatic control of fan based on cooling tower leaving-water temperature with control features to improve operating efficiency based on outdoor ambient wet-bulb temperature by using adaptive logic.
7. Fan motor sequencer for multiple-cell and two-speed applications with automatic lead stage rotation.
8. Collection basin level controller complying with requirements in "Electric/Electronic, Collection Basin Water-Level Controller with Makeup-Water Valve" Paragraph in "Collection Basin Makeup-Water Assembly" Article.
9. Vibration switch for each fan, complying with requirements in "Vibration Switch" Paragraph.
10. Oil-level switch for each fan with a gear drive, complying with requirements in "Gear-Drive, Oil-Level Switch" Paragraph.
11. Single-point, field-power connection to a fused disconnect switch.

    a. Branch power circuit to each motor and electric basin heater and to controls with a disconnect switch or circuit breaker.
    b. NEMA-rated motor controller, hand-off-auto switch, and overcurrent protection for each motor. Provide variable-frequency controller with manual bypass and line reactors for each variable-speed motor indicated.

12. Factory-installed wiring outside of enclosures shall be in metal raceway, except make connections to each motor and electric basin heater with liquidtight conduit.
13. Visual indication of status and alarm with momentary test push button for each motor.
14. Audible alarm and silence switch.
15. Visual indication of elapsed run time, graduated in hours for each motor.
16. Cooling tower shall have hardware to enable control system to remotely monitor and display the following:

a. Operational status of each motor.
b. Cooling tower leaving-fluid temperature.
c. Fan vibration alarm.

2.11 SOURCE QUALITY CONTROL

A. Performance Test: Factory test and certify cooling tower performance according to CTI STD 201RS, "Standard for the Certification of Water-Cooling Tower Thermal Performance."

1. Allow Owner access to place where cooling towers are being tested. Notify Owner in writing at least 30 days in advance of testing.
2. Prepare test report indicating test procedures, instrumentation, test conditions, and results. Submit copy of results within one week of test date.

B. Heat-Exchanger Factory Pressure and Leak Tests:

1. Pneumatically test heat-exchanger assembly while submerged underwater and prove to be free of leaks.
2. Test pressure equal to 1.5 times rated pressured, but not less than psig.
3. Submit report documenting test and results.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine cooling towers before installation. Reject cooling towers that are damaged.

B. Before cooling tower installation, examine roughing-in for tower support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting cooling tower performance, maintenance, and operation.

1. Cooling tower locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
2. Verify sizes and locations of concrete bases and support structure with actual equipment.
3. Verify sizes, locations, and anchoring attachments of structural-steel support structures.
4. Verify sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment.

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

3.2 INSTALLATION

A. Install cooling towers on support structure.

B. Equipment Mounting:

1. Install cooling towers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."

C. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Maintain clearances required by governing code.

F. Loose Components: Install components, devices, and accessories furnished by manufacturer with the cooling tower that are not factory mounted.

1. Loose components shall be installed by manufacturer's factory-trained service personnel.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to cooling towers, allow space for service and maintenance.

C. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.

D. Install drain piping with valve at cooling tower drain connections and at low points in piping.

E. Connect cooling tower overflows and drains, and piping drains, to sanitary sewage system.

F. Makeup-Water Piping:

1. Comply with applicable requirements in Section 221116 "Domestic Water Piping."
2. Connect to makeup-water connections with shutoff valve, plugged tee with pressure gage, flow meter, and drain connection with valve and union.

G. Supply and Return Piping:

1. Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
2. Connect to entering cooling tower connections with shutoff valve, strainer, balancing valve, thermometer, plugged tee with pressure gage, and drain connection with valve.
3. Connect to leaving cooling tower connection with shutoff valve thermometer, plugged tee with full port ball valve for portable field instruments, and drain connection with valve.
4. Make connections to cooling tower with a flange.

3.4 ELECTRICAL POWER CONNECTIONS

A. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.

B. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

C. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.

D. Install nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between cooling towers and other equipment to interlock operation as required to achieve a complete and functioning system.

C. Connect control wiring between cooling tower control interface and DDC system for remote monitoring and control of cooling towers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. Install label at each termination indicating control equipment designation serving cooling tower and the I/O point designation for each control connection. Comply with requirements in Section 260553 "Identification for Electrical Systems" for labeling and identification products and installations.

3.6 FIELD TESTING PROVISIONS

A. Include provisions for cooling tower future field-performance testing complying with CTI ATC 105.

B. Include provisions in field piping for future field-performance testing complying with CTI ATC 105.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections: Comply with CTI ATC 105.

E. Cooling towers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping; controls; and electrical connections for proper assemblies, installations, and connections.

C. Obtain performance data from manufacturer.

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

    a. Clean entire unit including basins.
    b. Verify that accessories are properly installed.
    c. Verify clearances for airflow and for cooling tower servicing.
    d. Check for vibration isolation and structural support.
    e. Lubricate bearings.
    f. Verify fan rotation for correct direction and for vibration or binding and correct problems.
    g. Verify pump rotation for correct direction, vibration, cavitation and flow and correct problems.
    h. Adjust belts to proper alignment and tension.
    i. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
    j. Check vibration switch setting. Verify operation.
    k. Verify water level in tower basin. Fill to proper startup level. Check makeup-water-level control and valve.
    l. Verify operation of basin heater and control.
    m. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
    n. Replace defective and malfunctioning units.

D. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.

E. Prepare a written startup report that records the results of tests and inspections.

3.9 ADJUSTING

A. Set and balance water flow to each tower inlet.

B. Adjust water-level control for proper operating level.

C. Adjust basin heater control for proper operating set point.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cooling towers.

1. Video record the training sessions.
2. Instructor shall be factory trained and certified.
3. Perform not less than 4 hours of training.
4. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
5. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
6. Obtain Owner sign-off that training is complete.
7. Owner training shall be held at Project site.

END OF SECTION 236514.17

SECTION 238126

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Operation and maintenance data.

D. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

2. Applicable requirements in ASHRAE 62.1-2013, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Ten years from date of Substantial Completion.
b. For Parts: Ten years from date of Substantial Completion.
c. For Labor: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following: Verify that manufacturers retained in the list below make combination of unit components retained.

1. Daikin Industries, Ltd.
2. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
3. Trane; a business of American Standard companies.

2.2 INDOOR UNITS 5 TONS OR LESS

A. Wall Mounted Cassette Type Evaporator-Fan Components: (AHU-10)

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.
4. Fan: Forward-curved wheel of galvanized steel; directly connected to motor.
5. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2013.
7. Filters: Permanent, cleanable.
8. Condensate Drain Pans:

    a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

    b. Single-wall, corrosive resistant material.
    c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

        1) Minimum Connection Size: NPS 1.
    d. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.3 OUTDOOR UNITS (CU-10)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Inverter.
    b. Modulating compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    c. Refrigerant Charge: R-410A.
    d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit.
7. Mounting Base: Polyethylene.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Thermostat: Wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.

2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Drain Hose: For condensate.

F. Additional Monitoring:

1. Monitor constant and variable motor loads.
2. Monitor variable-frequency-drive operation.
3. Monitor economizer cycle.
4. Monitor cooling load.
5. Monitor air distribution static pressure and ventilation air volumes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounted, compressor-condenser components on a concrete base that is provided by others. Coordinate anchor installation with concrete base.

D. Install roof-mounted, compressor-condenser components on equipment supports specified in Division 07 Section "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

E. Install compressor-condenser components on neoprene isolation pads. See Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts" Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specification sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1- General Requirements” form a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

B. Contractor: “Contractor”, “this Contractor” or “Electrical Contractor” when used in Divisions 26, 27, and 28 Specification Sections refers to the Contractor responsible for all work under this section.

C. Sub-Contractor: Any reference to, or letting of work contained in these specifications to any Sub-Contractor or Manufacture does not relieve this Contractor for all work, material and equipment in these specifications.

D. All references made to any item in the singular number shall apply to as many identical items that the work may require.

E. Where applicable, all materials and equipment shall bear the label of the Underwriters Laboratory, Inc., or other nationally recognized testing laboratory and shall be used and/or installed in accordance with any instructions included with the listing or labeling.

F. The sizes of conductors and thickness of metals shown on the drawings or mentioned herein shall be understood to be American Wire Gauge.

G. All materials shall be made from steel manufactured in America and certification shall be submitted.

H. Any reference made to the “Engineer” in these specifications shall refer to the Personnel of the Engineering Design Division of the Department of General Services.

I. Any reference made to the “Department” in these specifications shall refer to the Personnel of the Department of General Services.

J. Any reference made to the “Using Agency” in these specifications shall refer to the Personnel of the Department of Military & Veteran’s Affairs.

1.2 SUMMARY

A. This Section applies to all Divisions 26, 27 and 28 Sections and includes the following:

1. General Provisions:

a. Definitions.

b. Intent.

c. Work Included.

d. Responsibility of Bidders.

e. Quality Assurance.

f. Submittals.

g. Substitutions.

h. Guarantees.

i. Regulations.

j. Standards and References.

k. Permits and Inspections.

l. Project/Site Conditions.

m. Delivery, Storage and Handling.

n. Protection of Services and Equipment.

o. Sequencing, Scheduling and Coordination.

p. Type of Service.

q. Incoming Electric Service Facilities.

r. Interruption of Services.

s. Temporary Electrical Service.

t. Hazardous Materials.

u. Operating and Maintenance Manuals.

v. Record Drawings.

w. Electrical/Mechanical Sound Control.

x. Final Acceptance.

y. Using Agency Instruction.

2. Products:

a. Vibration Isolators.

b. Access Panels.

c. Concrete Work.

d. Painting.

e. Touchup Paint.

3. Execution:

a. General Installation.

b. Electrical Equipment Installation.

c. Demolition.

d. Existing Panelboards.

e. Existing Wiring.

f. Equipment Connection.

g. Splices.

h. Terminals and Connectors.

i. Balancing.

j. Excavation and Backfilling.

k. Field Quality Control.

l. Core Drilling.

m. Cutting and Patching.

n. Cleaning.

o. Refinishing and Touchup Painting.

p. Mounting Heights.

1.3 DEFINITIONS

A. Provide: The term "provide", as used in these specifications and on the drawings, shall be understood to mean "the Contractor shall furnish and install, complete and operational, with all required hardware, accessories and appurtenances." Unless indicated otherwise, this shall also

include all associated power and/or signal wiring required for electrical systems furnished under this Contract.

B. Concealed: Where the word “concealed” is used in conjunction with raceways, equipment and the like, the word is understood to mean hidden from sight as in chases, furred spaces or suspended ceilings.

C. Exposed: Where the word “exposed” is used in conjunction with raceways, equipment and the like, the word is understood to mean open to view.

D. Approved Equal: Where the phrase “or approved equal,” “or equal,” or “approved” appears, it shall refer to the approval of the Engineer on the materials or equipment involved.

1.4 INTENT

A. Provide complete and fully operational electrical systems with facilities and services to meet all of the requirements described herein and in complete accordance with all applicable codes and ordinances.

1. The manufacturer's recommendations for the particular equipment or system, the National Electrical Code and the Engineer shall determine what is the complete and proper installation and proper operation. The Engineer shall make the final determination.

B. The drawings are diagrammatic and approximately to scale, unless noted otherwise. They establish scope, material and quality and are not detailed installation instructions.

C. The Contractor shall be held responsible for proper installation of materials and equipment to true intent and meaning of both Drawings and Specifications.

D. In cases of discrepancies between the drawings and the specifications, the Engineer will make the final determination. In cases where items appear in the specifications but not on the drawings, or appear on the drawings but not in the specifications they shall be considered as noted on both. Unless written clarification in the form of an addendum is received, the bid shall be interpreted to include the most expensive installation, equipment or work and all associated costs.

E. The Engineer reserves the right of interpretation of the specifications and drawings. The Engineer’s decisions of specification and drawing interpretations shall be final.

1.5 WORK INCLUDED

A. Refer to Division 1, General Requirements, specification section 01010, Summary of Work for details of work included in project.

1.6 RESPONSIBILITY OF BIDDERS

A. Examine all contract documents issued. Visit the site and become thoroughly acquainted with the existing conditions prior to submitting a bid. The submission of a bid shall be considered as

evidence that a site visit was conducted; no extra compensation will be allowed for any error resulting from failure to visit job site. Prior to submitting a proposal, bidders must familiarize themselves with the codes, rules, and regulations in effect at the site of the work, to determine existing conditions that affect their installation.

B. Carefully examine the Architectural, Structural, Heating, Ventilating, Air Conditioning, Plumbing, Fire Protection, and/or Miscellaneous Contract Drawings and Specifications. If any discrepancies occur between the drawings or between the drawings and specifications, report such discrepancies to the Engineer in writing and obtain written instructions as to the manner in which to proceed. Do not make departures from the Contract Drawings without prior written approval of the Engineer.

C. Execute all work, construct and install all equipment in accordance with the current requirements of all Occupational Safety and Health Administration (OSHA), National Fire Protection Association (NFPA), the National Electrical Code (NEC) as amended to date L&I has adopted, Underwriters Laboratories (UL), National Electrical Manufacturers Association (NEMA), insurance underwriters of the Using Agency and/or other authorities having jurisdiction over premises, public utilities which have connection with any systems specified, and all Federal, State, County and Local ordinances and regulations. Nothing contained in these specifications or shown on the drawings shall be construed to conflict with the aforesaid codes, ordinances, or regulations. Contractor shall be held responsible for accident to persons, material or property caused by failure to adhere to the proper code requirements until the Department has accepted work.

D. The Contractor shall be qualified or licensed to perform the types of work involved under this Division of the Specifications, in the state, county and/or municipality of this project as required.

E. Wherever any installation, product, equipment item, etc. specified herein is not permitted to be handled or installed, or is otherwise restricted by union regulations, etc., notify the Department in writing before submitting a bid, in ample time for modifications in the requirements to be made. If such notification is not given, this Contractor shall be responsible to complete the installation as specified, to the Department's satisfaction, and at no additional cost.

1.7 QUALITY ASSURANCE

A. Products Criteria:

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least three years. See applicable specification sections for any additional requirements.

2. Equipment Service: Products shall be supported by a service organization that maintains a complete inventory of repair parts and is located reasonably close to the site.

3. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

4. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

5. Nameplates: Nameplates bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.

B. Manufacturer's Recommendations: Install materials in accordance with manufacturer's recommendations.

1.8 SUBMITTALS

A. General Requirements Applicable to all Divisions 26, 27 and 28 Sections:

1. Submit in accordance with Division 1, General Conditions, Section 01300 and the following:

a. Prior to ordering equipment, submit to the Engineer a complete list of proposed equipment and materials, giving the name and address of manufacturer and, when required for proper identification, trade names or catalog numbers. Itemize each type of material and each piece of equipment (omitting duplicates).

b. Submit shop drawings and product data grouped to include complete submittals of related systems, products and accessories in a single submittal. Produce shop drawings to indicate fabrication details and proposed layouts for shop or field fabrications as named herein.

c. Mark dimensions and values in units to match those specified. Include contract drawing identification, type, quantities, capacities, accessories, rough-in dimensions, manufacturer's name, model number, connection sizes, wiring diagrams, installation instructions, motor horsepower, voltage, phase and amperage, colors, finishes and other pertinent data.

d. The submissions are the contractor's documents; the Engineer's approval constitutes an acknowledgment that the documents have been submitted and nothing more. It is the contractor's responsibility to check his own submissions for compliance with the Contract Documents, job conditions, and coordination with the work and equipment of the other trades.

e. Certify, by submittal, that the materials or equipment proposed are satisfactory for the intended application, and that the materials or equipment are in current production with no known plans to cease manufacture.

f. Submittals processed by the Engineer do not constitute change orders. The purpose of the submittal process is to demonstrate the Contractor's understanding of the design concept; the Contractor demonstrates this understanding by indicating which equipment and materials he intends to provide, and the fabrication and installation methods that he intends to use.

g. If deviations, discrepancies or conflicts between shop drawing submittals and the contract documents (in the form of design drawings, specifications and addenda) are discovered, either prior to or after shop drawing submittals are processed by the Engineer, the contract documents shall control and shall be followed.

h. All submittals shall bear the Contractor's approval stamp as evidence that he has checked the drawings. Any submittals without this stamp of approval will not be evaluated and will be returned to the Contractor for proper resubmission. Material and equipment reviews by the Engineer are only for general conformance to the design intent of the project and compliance with information given in the contract documents. Dimensions shall be confirmed and correlated at the job site by the installing Contractor and installation shall be coordinated with other trades.

i. Coordination composite drawings among the HVAC, Plumbing, Fire Protection, Electrical and Ceiling Contractors are required, with the lead role assigned by the Department. The Lead Contractor shall conduct coordination meetings with all other trades to discuss and resolve interference problems. Once each trade Contractor has initialed the coordination drawings to indicate approval, the Lead Contractor shall submit the drawings to the Engineer for review. The other trade Contractors should finalize their shop drawings in accordance with the coordination drawings, and submit for Engineer's review.

j. Submit samples of materials for approval at the site as requested by the Engineer. Such materials may be incorporated into the project after approval and serving their purpose as samples.

1.9 SUBSTITUTIONS

A. Submit substitution proposals in accordance with provisions of Division 1, General Conditions and the following:

B. Throughout the specifications, types of materials may be specified by manufacturer's name and catalog number in order to establish standards of quality and performance and not for the purpose of limiting competition. Unless specifically stated otherwise, assume the phrase "or approved equal", except that the burden is upon the Contractor to prove such equality. If the Contractor elects to prove such equality, he shall request, in writing, review of the substitution by the Department in accordance with all Supplementary Conditions and/or Division 1 requirements. All such requests shall include manufacturer's literature, specifications, drawings, catalog cuts, performance data or other references or information necessary to completely describe the item. The Contractor shall be responsible for all structural, mechanical, and electrical changes required for their installation, at no additional cost to the Department.

C. A substitution request constitutes a representation that the Contractor:

1. Has investigated the proposed product and determined that it meets or exceeds the quality level of the originally specified product.

2. Will provide the same or greater warranty than the originally specified product.

3. Will coordinate the installation and make changes to all other work including coordination and compensation to other trades that may be required for the substituted product to be installed with no additional cost to the Department.

4. Waive claims for additional costs or time extensions, which may subsequently become apparent.

D. When this contractor desires to furnish equipment of a manufacturer other than that specified or intended, he shall include a complete specification of the substituted item, along with each submission copy of shop drawings, indicating the necessary modifications to the substituted product to satisfy the requirements of the contract specifications. Manufacturer's specifications shall be written as close as possible over the contract specifications so that an accurate comparison can be made.

E. The verification specification shall include the exact wording of the contract specification and the revised wording, identified properly, indicating all the deviations proposed. If no deviations are noted, the contractor shall furnish the material or equipment in accordance with the contract specifications.

F. Substitutions will be considered when a product becomes unavailable through no fault of the Contractor.

G. Also, when the contractor submits equipment or materials of the manufacturers specified, verification specifications must be submitted at the request of the Engineer.

H. In cases where specific manufacturers are listed, the Engineer reserves the right to consider alternate manufacturers.

I. The Engineer reserves the right of final acceptance of substitutions.

1.10 GUARANTEES

A. Submit equipment warranties in accordance with provisions of Division 1, General Conditions and the following:

B. Guarantee all equipment, materials, and workmanship for a minimum of one year following date of acceptance of the project. Provide additional/special warranties where called for in the technical specifications.

C. Warranty shall be in writing and shall include written copies of factory warranties with expiration dates on items of equipment where warranty date might differ from the acceptance date. No warranty shall start before date of acceptance in writing by the Department. Repair or replace any defective work developing during this period, at no additional cost. Where defective electrical work results in damage to work of other contracts, this contractor shall be responsible to repair and/or restore such work to its original condition, again at no additional cost to the Department.

D. The equipment and materials manufacturers are expected to recognize that they are responsible for the failure of their products to perform in accordance with data furnished by them or their authorized representatives, as well as misrepresentations of such data. If the products have been

installed in accordance with the manufacturers published or written instructions and recommendations, and such products fail, then the Contractor and the manufacturers are responsible for replacement of the products and all associated work and materials, at no cost to the Department.

1.11 REGULATIONS

A. All electrical work, equipment and material furnished or installed under this contract shall conform to requirements of the latest codes and any other Governmental or Local Authorities having jurisdiction and of all rules and regulations of Utilities involved. Nothing mentioned in the specifications or indicated on the drawings shall be construed to conflict with mentioned codes, ordinances and regulations. The following codes shall be followed:

1. Pennsylvania Uniform Construction Code (UCC)

2. National Electrical Code (NFPA 70)

3. National Electrical Safety Code (NESC-ANSI-C2)

4. Life Safety Code (NFPA 101)

5. National Fire Alarm Code (NFPA 72-2008)

6. International Code Council Series (ICC-2009)

7. Pennsylvania Department of Environmental Protection (DEP)

8. Pennsylvania Department of Labor and Industry (L&I)

9. Americans with Disabilities Act (ADA)

10. Occupational Safety & Health Agency (OSHA)

11. Applicable utility company rules and regulations.

12. Applicable Federal, State, and Local (or any other authority having jurisdiction) laws, rules and regulations.

1.12 STANDARDS AND REFERENCES

A. Products of workmanship that are specified by association, trade, or federal standards shall comply with the requirements of the following reference standards, except when more rigid requirements are specified or are required by applicable code:

1. American National Standard Institute (ANSI)

2. American Society for Testing and Materials (ASTM)

3. Factory Mutual System (FM)

4. Institute of Electrical and Electronics Engineers (IEEE)

5. Illuminating Engineering Society of North America (IESNA), Lighting Standards and Recommended Practices

6. National Electrical Manufactures Association (NEMA)

7. National Fire Protection Association (NFPA)

8. Underwriters Laboratories, Inc. (UL)

9. Updated Standards: At the request of the Engineer, Contractor or governing authority, submit a change order proposal where an applicable industry code or standard has been revised and reissued after the date of contract documents and before performance of the work affected. The Engineer will decide whether to issue a change order to proceed with the updated standard.

1.13 PERMITS AND INSPECTIONS

A. Refer to Division 1 – General Requirements.

1.14 PROJECT/SITE CONDITIONS

A. Refer to Division 1 - General Requirements.

B. Install work in locations shown on the drawings, unless prevented by project conditions

C. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other sections. Obtain permission of the Engineer before proceeding.

D. Perform all minor cutting and patching, and make all changes, relocations and installations with a minimum of noise. All present and new equipment, floors, walls, etc., shall be adequately protected from dust and dirt caused by the work. Protection shall include suitable temporary barriers or coverings. Maintain exterior and interior premises of the building as clean as possible during construction. At no time shall the Contractor interfere with the normal operation of the building by allowing debris, excess earth, etc., to remain on the premises.

1.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 1 - General Requirements.

B. Deliver materials and equipment to the project site in a clean condition with openings plugged or capped (or otherwise sealed by packaging) both during shipping and during temporary storage. Deliveries shall be scheduled to minimize the amount of time in temporary storage.

C. Delivered equipment crating and/or packaging shall clearly identify pick points or lifting points. In the absence of crating or packaging, pick points or lifting points must be identified on the equipment.

D. When unloading material and equipment, provide special lifting harness or apparatus as required by the manufacturer. Handle materials and equipment in accordance with manufacturer's written instructions.

E. Determine the required equipment needed for unloading operations and have such equipment on site to perform unloading work on the date of equipment delivery.

F. Store materials on site only where directed by the Department. Materials and equipment, both on site and off site, shall be stored in accordance with manufacturers written instructions. Store all materials in dry locations, off ground and keep moisture free at all times.

G. The Contractor shall protect at his own expense, his work, materials, and equipment during construction. Units and devices, both before and after being set in place, shall be securely protected from carelessly or maliciously dropped tools, materials, grit, dirt or any foreign matter. Contractor shall be held responsible for damage so done until work is fully and finally accepted.

H. The Contractor shall be entirely responsible for all apparatus, equipment and appurtenances furnished by him or his subcontractors in connection with the work, and special care shall be taken to protect all parts thereof in such manner as may be necessary or as may be directed. Protection shall include covers, crating, sheds or other means to prevent dirt, grit, plaster, or other foreign substances from entering the working parts of machinery or equipment. Where equipment must be stored outside the building, it shall be totally covered and secured with heavy, waterproof tarps and kept dry at all times. Where equipment has been subjected to moisture, it shall be suitably dried out before placed in service. Materials and equipment shall be stored in areas designated by the Department.

I. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products and equipment to assure that they are being maintained under specified conditions, and free from damage or deterioration.

1.16 PROTECTION OF SERVICES AND EQUIPMENT

A. This Contractor shall, at his own expense, repair, replace and maintain in service any utilities, facilities or service (underground, overhead, interior or exterior) damaged, broken, or otherwise rendered inoperative during the course of construction by him or his representatives. The method used by this Contractor in repairing, replacing or maintaining the services shall be approved by the Department.

1.17 SEQUENCING, SCHEDULING AND COORDINATION

A. Refer to Division 1 - General Requirements.

B. 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.

C. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.

D. 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.

E. Interference:

1. The drawings are generally diagrammatic and indicative of the work. The Contractor is responsible for modifying the work with offsets, bends, or other fittings to avoid minor interference's and structural obstructions. Perform such modifications at no increase in cost to the Department.

2. In the event that interferences develop, the Engineer’s decision will be final and no additional compensation will be allowed for relocation of electrical equipment.

F. Contract Interface:

1. Work performed in cooperation with other contracts: The responsibility for performing work of this contract in cooperation with work of other contracts rests solely with this Contractor.

a. Make connections of electrical systems specified in the various sections of this contract to those systems or installations of other contracts requiring such connections.

b. These connections are generally indicated as contract breaks on the drawings.

1.18 TYPE OF SERVICE

A. Existing Electric Service shall remain: - 120/240V-3 phase, 4 wire (High-Leg), 800A, 60 HZ, alternating current.

1.19 INCOMING ELECTRIC SERVICE FACILITIES

A. Provide all electrical facilities as shown on the drawings, hereinafter specified or as required for maintaining the existing electric service entrance during construction.

1.20 INTERRUPTION OF SERVICES

A. Refer to General Conditions of the Contract.

B. At beginning of the project, review the procedures of the Using Agency relating to utility interruptions and plan the electrical work accordingly. Develop a preliminary utility interruption schedule and submit to the Using Agency for approval before developing final project schedules.

C. Schedule the work to avoid major interruptions of any utility services. Interruption of services shall be done during overtime if necessary at no additional cost to the Department.

D. Notify the Using Agency in writing a minimum of five working days prior to any interruption of services.

1.21 TEMPORARY ELECTRICAL SYSTEMS

A. Refer to Division 1 - General Requirements.

1.22 HAZARDOUS MATERIALS

A. Should hazardous or toxic materials be encountered in any existing work, the Contractor shall notify the Department.

1.23 OPERATING AND MAINTENANCE MANUALS

A. Submit under provisions of Division 1 and in accordance with the following:

B. Provide heavy-duty catalogue binders with appropriate labeling.

C. Binder shall be indexed by material and/or system type and at a minimum shall include:

1. Title page with clear plastic protection cover.

2. List of Drawings.

3. Description of Systems: Provide complete and detailed description of systems.

4. Operating Division: Provide complete and detailed operation of major components.

5. Maintenance Division: Provide preventative maintenance schedule for major components.

6. List of Equipment Suppliers and Contractors: Provide list of equipment suppliers and contractors, including address and telephone number.

7. Certification: Include copy of tests performed on insulation, grounding, continuity, phase balancing and signal systems; electrical equipment tag identification and wiring color

code; inspection approval certificates for electrical systems and operational tests on applicable electrical equipment.

8. Shop Drawings and Maintenance Bulletins: Provide materials received in compliance with clause 'Shop Drawings', arrange alphabetically.

D. Divider Tabs: Laminated Mylar plastic and colored according to Section.

E. Submit documents for approval prior to being turned over to the Using Agency.

1.24 RECORD DRAWINGS

A. Submit under the provisions of Division 1 and in accordance with the following:

B. Keep on site at all times an extra set of drawings and specifications recording changes and deviations from contract documents including all addendum, bulletin and request for information data. Documents shall be updated on a daily basis. This set of documents shall be used specifically for this purpose.

C. The record drawings shall accurately reflect the as-built conditions at the time of the project completion.

D. Record drawings shall be presented with maintenance manuals to the Department at the time of final acceptance of the project.

1.25 ELECTRICAL/MECHANICAL SOUND CONTROL

A. All equipment shall operate without objectionable noise or vibration within Noise Criteria Curves listed in Sound Control Fundamentals of the latest edition of the ASHRAE Handbook of Fundamentals. Sound and vibration measurements shall conform to the ASHRAE Handbook of Fundamentals. If such objectionable noise or vibration shall be produced and transmitted to occupied portions of the building by electrical/mechanical equipment (i.e. generators, transformers, etc.) or other parts of this work, any necessary changes, as approved shall be made without additional cost to the Department. Noise levels shall conform to the requirements of OSHA.

B. Any and all other insulation or isolation required to accomplish results specified above shall be furnished and installed without additional cost to the Department.

C. Isolation systems shall be installed in strict accordance with the manufacturer’s written instructions and submittal data. Locations of all vibration isolation products shall be selected for ease of inspection and adjustment, as well as for proper operation.

D. No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation system herein specified. Electrical conduit connections to isolated equipment shall be looped to allow free motion of isolated equipment.

1.26 FINAL ACCEPTANCE

A. Refer to Division 1 - General Requirements.

B. When the installation is reported in writing by the contractor to be complete and ready for acceptance, an inspection shall be made by the Contractor in the presence of the Department to ascertain whether it complies with the contract documents. If in the opinion of the Department it fails to do so, the Contractor shall at once remedy all defects and shortcomings. Any additional tests that may be required shall be entirely at the Contractor's expense. All of the testing work shall be done when and as directed by the Department.

1.27 USING AGENCY INSTRUCTION

A. The Contractor shall furnish the services of qualified personnel, approved by the Engineer and thoroughly familiar with the completed installation, to instruct the permanent operating personnel of the Using Agency in the proper operation of all systems included under this contract, and the proper care of all equipment and apparatus. These services shall be furnished for a period of one 8-hour day, after the operation of the systems has been taken over by the Using Agency.

B. When instructions are provided under this contract, the Contractor shall have in his possession three copies of an identifying letter which shall list the names of the Contractor's qualified instruction personnel, including manufacturers' representatives and subcontractors that will be giving the instructions. Likewise, on this same letter, spaces shall be provided for the personnel of the Using Agency who will receive the instructions. After instructions have been given and received for each system, the Contractor's representatives and subcontractors shall sign and date the letter, and the Using Agency personnel attending shall sign and date the letter acknowledging that they have received adequate instructions for operating and maintaining the systems and equipment. One signed copy shall be delivered to the Using Agency, one copy to the Department and one copy shall be retained by the Contractor.

C. In addition to the verbal instructions outlined above, the Contractor and his manufacturers' representatives and subcontractors shall furnish written basic instructions indicating the proper operation of each system and associated equipment. Each manufacturer shall also submit a brochure on his equipment, including instructions on operation, recommended spare parts, and instructions on preventative, routine and breakdown maintenance.

D. The Contractor shall combine the written instructions and the manufacturers' equipment brochures in complete volumes with hardback binders which shall be turned over to the Using Agency before final acceptance of the contract work. The Contractor shall obtain two copies of a signed receipt from the Using Agency for the written instructions and equipment brochures. One copy of the receipt shall be delivered to the Engineer and one copy retained by the Contractor.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Neoprene Isolation Pads:

1. Neoprene isolation pads shall be single rib or crossed, double rib neoprene in shear pads, in combination with steel shims when required, having minimum static deflections as tabulated. All neoprene pads shall be true neoprene in-shear using alternately higher and lower ribs to provide effective vibration isolation, and shall be molded using 2500 psi tensile strength, oil resistant, compounds with no color additives. Pads shall be 45 or 65 durometer and designed to permit 60 to 120 psi loading, respectively, at maximum rated deflections. Neoprene in-shear isolation pads shall be provided to meet tabulated minimum operating static deflections without exceeding published maximum static deflections. Use single or, crossed, double rib or laminated composites of both as required. When two pads of ribbed material are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate.

2.2 ACCESS PANELS

A. Furnish factory-fabricated access panels for access to all concealed pull boxes, junction boxes, capped conduits and other electrical equipment where no other means of access is available. Access panels for electrical work, along with all required auxiliary or supporting steel, hardware, etc., shall be furnished by the electrical contractor to the general contractor, who shall install them. Access panels are not required at lift-out removable tile ceilings.

B. Access panels shall be of appropriate size but not less than 16" x 12". Panels shall be all steel construction with a #16 gauge wall or ceiling frame and a #14 gauge panel door. Doors shall be provided with concealed hinges and cylinder lock except doors for wall panels which may be secured with suitable clips and countersunk screws. Outside of access panels shall be finished flush with finished walls or ceilings surfaces and shall be prime painted.

C. At locations where access panels are installed in fire-rated ceilings, access panels shall contain the 1-1/2" hour fire-rated "B" label, and, in addition, shall also be provided with layers of gypsum wallboard in a thickness which will supply an additional one-hour fire rating. Consider all ceiling access panels required in gypsum board or plaster ceilings to be 1 hour rated unless otherwise noted on the Architectural drawings.

D. Determine the exact locations and sizes of required access panels and coordinate same with the Department. Access panels shall not be installed without prior approval of the Department. All panels shall be installed and located to present a neat and symmetrical appearance.

E. Junction boxes, capped conduits and other electrical equipment above removable tile ceilings or above panels shall be suitably identified by small, inconspicuous adhesive-backed labels attached to the ceiling surface or the surface of the access panel. Labels shall be additionally secured with screws or rivets. Labels shall be white with 3/8" high black letter and shall be a manufactured item for that purpose.

2.3 CONCRETE WORK

A. Refer to Division 3 – Cast-In-Place Concrete.

B. This Contractor shall provide all concrete for equipment foundations, duct-banks and patching as specified or otherwise required for completion of work.

1. Concrete for equipment foundations and pole bases shall be Pennsylvania Department of Transportation, Class A, rated 4000 pounds/square inch at twenty-eight (28) days. Equipment foundations shall be properly dwelled in with floor construction, and shall have slopped bevels on all horizontal and vertical edges. Foundations shall be 4" high, unless otherwise indicated. Foundations shall be reinforced with 6"x 6" #10 gauge wire mesh and anchored through floor construction with ¾" diameter bolts or rods. Anchor bolts for equipment shall be placed in foundations before equipment is set. Foundations shall be of sufficient size for equipment and shall extend a minimum of 4" beyond equipment on all sides.

2. Concrete for conduit encasement shall be Pennsylvania Department of Transportation Class A, rated 3,300 pounds/square inch at twenty-eight (28) days.

3. All concrete shall be obtained from an approved source. Concrete testing is not a requirement, however, batch slips shall be given to the inspector for checking.

4. All concrete shall be 6% air entrained and the slump of concrete shall not exceed three inches. All concrete shall be thoroughly compacted by the use of mechanical vibrators.

5. All work associated with the handling, placing of reinforcing steel and curing shall be done according to the recommendations of the American Concrete Institute and Concrete Reinforcing Steel Institute, and all materials shall conform to the American Society for Testing Materials Specifications, applicable to this work.

6. To insure adequate curing, do not remove forms from vertical surfaces for five (5) days after casting unless other approved means are taken to prevent premature drying of concrete. Keep all horizontal surfaces continuously wet for seven (7) days with mechanical sprinklers or coat with an impervious sealer, applied in atomized form at a rate of not less than one (1) gallon per two hundred square feet after surface water has entirely disappeared, but while surfaces are still moist. This compound shall form an effective seal which will prevent evaporation of moisture from concrete for the full curing period, and shall be used in strict accordance with the manufactures published recommendations.

7. Provide adequate equipment for heating the concrete and protecting the concrete during freezing or near freezing weather. All concrete materials, reinforcement, forms and ground with which the concrete will come in contact shall be free of frost.

8. After the first frost and until the mean daily temperature at the site falls below 40 degrees for more than one (1) day, protect concrete from freezing for not less than the first forty-eight (48) hours after it is placed. When the mean temperature falls below 40 degrees for more than one (1) day, place concrete thereafter at a temperature not lower than 55 degrees and not higher than 70 degrees, and maintained not lower than 55 degrees for at least the first three (3) days. During the next three (3) days protect from freezing. When

the mean daily temperatures rise above 40 degrees for more than three (3) successive days, placement and maintenance of concrete for three (3) days at or above required minimum temperatures may be discontinued, but concrete should not be exposed to freezing temperatures for at least forty-eight (48) hours after placing.

2.4 PAINTING

A. This Contractor shall paint all exposed raceways, hangers, junction boxes, etc., that this Contractor installs in finished areas. Finished areas shall be those areas where the surfaces are plastered, glazed tile, painted block, etc. This Contractor is not responsible for any other painting except as otherwise noted.

B. Where the Contractor is the only Contractor working in a specified area, he shall be responsible for painting equipment and related raceway, if classified a finished area.

2.5 TOUCH-UP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

C. Panelboard trims and doors, safety switch and circuit breaker enclosures, and items of similar nature shall be baked enamel finished at the place of manufacture. Damage to the factory finish due to shipment or installation shall be "touched-up" by this Contractor with factory supplied paint

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

A. All work shall be installed in a neat and workmanlike manner by craftsmen experienced in the trade involved and shall be acceptable to the Department. All details of installation shall be mechanically and electrically correct. All materials and equipment shall be new, and without imperfections or blemishes, unless otherwise noted. Before ordering any material or doing any work, the Contractor shall verify all measurements at the site and shall be responsible for the correctness of same.

B. The Contractor shall lay out his work from dimensions of bid documents, actual dimensions taken at the site, and from the approved dimensions of equipment being installed. Layouts in congested areas should not be scaled from the electrical and mechanical drawings. No extra compensation will be allowed on account of difference between actual dimensions and measurements and those indicated on the drawings. Any difference, which may be found, shall be submitted to the Department for consideration before proceeding with the work.

C. This specification includes under each item all labor, material and equipment necessary to properly install complete, adjust, and place in operating condition, satisfactory to the Department, the several branches of work described herein. This shall include all necessary

interconnections between the several branches of work described herein, and connections to work under other sections of specifications and other contractors.

D. All items of labor, material or equipment not described in detail by specifications or drawings, but which are incidental to or necessary for complete installation and proper operation of several branches of work described herein, or reasonably implied in connection therewith, shall be furnished and/or installed as if called for in detail by drawings or specifications.

E. The drawings are generally indicative of the work required and shall be followed as closely as circumstances will permit, however they do not indicate all bends, fittings, boxes and accessories which may be required. The Contractor shall carefully investigate structural and finish conditions affecting work and arrange work accordingly, furnishing such fittings, accessories, etc., required to meet such conditions. Contractor will be held responsible for proper installation of materials and equipment to the true intent and meaning of contract documents.

F. The Contractor shall carefully examine all contract documents including those of all other trades, and carry on his work so as not to delay or interfere with the work of other trades. He shall obtain in writing from the other contractors such data as is necessary to coordinate his work with other trades.

G. The drawings indicate approximate location of wiring, outlets, equipment, etc., and the actual location shall be confirmed at the site with the Department. The department reserves the right to make minor changes in the locations of conduits, outlets, equipment, etc. prior to roughing-in, without incurring additional expense to the Department.

H. Coordinate location of luminaires, conduit, wire, wiring devices, equipment, etc., to be clear of windows, doors, openings, diffusers, return grilles, sprinklers and other services and utilities. This Contractor shall be held responsible to coordinate his work with that of the other trades so that all work may proceed in an orderly manner and conflicts and delays may be avoided. Where drawings indicate special space allocation for different contracts, contractors shall rigidly adhere to sequence of installation designated by the Department or as required to allow all the trades to work equipment or materials into place in respective order. Special attention shall be paid to work under the floor slabs, above ceilings and in locations otherwise concealed. All work shall be tested before it is closed in.

I. Secure dimensions of all recessed lighting fixtures, telephone, data and similar device outlets and other equipment immediately upon the award of the Contract. Work closely with the General, HVAC, Plumbing and other Contractors and provide them with the necessary information and dimensions so that there will be no interference between piping, duct work, structural steel, furring channels, etc., and recessed lighting fixtures or other electrical equipment.

J. In case interference or fouling results, the Department shall decide which item is to be relocated, regardless of which is installed first. The Contractor shall receive no additional compensation for relocating items that result from interference with other work.

K. Contractor shall determine in advance, location and size of chases and openings necessary for proper installation of his work, and have same provided during erection of work in which chases and openings occur. He shall furnish and set sleeves, hangers, and anchors, and be responsible for their proper and permanent location.

L. In cases where cutting of new building construction is necessary due to failure to set proper sleeves or inserts, or due to the failure to provide proper openings and chases such cutting shall be done and repaired to match the original condition of the work by the contractor under this specification.

M. Points of connection and termination of work under this specification are shown on drawings or stated within the specification, but in case of doubt as to such points, the Department's decision will be final.

N. Follow manufacturer's published recommendations for installation methods not otherwise specified. The Contractor shall furnish the services of manufacturer's representatives for each piece of major equipment furnished under these contract documents. The amount of factory service provided by the contractor shall be as normally recommended and furnished by the various equipment manufacturers unless specified otherwise. Testing of equipment shall be made under the direct supervision of competent authorized service representatives. Any and all expenses incurred by the equipment manufacturers' representatives shall be borne by the contractor.

O. Contractor shall seal all openings left in building construction by the installation of work specified under this section. Sealing shall be in accordance with "Cutting and Patching" section specified herein.

P. Where the vapor barrier of any insulation is broken due to the installation of conduit and equipment, the Contractor shall properly repair all insulation and seal all openings with vapor barrier covering and vapor barrier adhesive of type installed with the insulation.

Q. Upon completion of the work, all remaining waste materials and rubbish resulting from the contract work shall be removed from the building and premises.

R. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Department for clarification. Do not proceed with work without clear instructions.

S. The Contractor and his subcontractors shall satisfactorily complete the systems so that they are functional and operating to the satisfaction of the Department. All systems, their controls and their sequencing must be demonstrated to the satisfaction of the Department.

3.2 ELECTRICAL EQUIPMENT INSTALLATION

A. Headroom Maintenance: If mounting height or other location criteria is not indicated, arrange and install components and equipment to provide the maximum possible headroom.

B. Materials and Components: Install level, plum, 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.

D. Connect for ease of disconnecting, with the minimum interference with other installations.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.3 DEMOLITION

A. Existing Equipment:

1. To accommodate the renovations, disconnect and remove or relocate existing equipment and services as indicated on the plans or as required (whether or not the existing equipment is shown on the drawings). All other existing equipment shall be removed, unless otherwise noted.

2. If new equipment such as receptacles, light fixtures, etc. is to be installed where an existing device is located, the existing outlet box may be reused if it complies with all applicable codes.

3. All existing building equipment to be removed that would be of some value to the Using Agency, such as light fixtures, time clocks, safety switches, panelboards, etc., shall be removed by this Contractor and turned over to the Using Agency for storage.

4. It is this Contractor's responsibility to pay disposal fees for equipment removed. Equipment shall be disposed of in accordance with governing environmental regulations (i.e. ballasts, lamps, transformers, batteries, etc.).

B. Removal of Existing Circuits:

1. Where it is noted for switches, receptacles, fixtures or other electrical equipment to be disconnected and removed; it shall be understood that all wiring, junction boxes, supports, appurtenances and accessories associated with the equipment (not required to remain, due to continuity or other necessity) shall be removed in their entirety.

C. Extension of Existing Circuits:

1. Where existing equipment is indicated as being relocated and a circuit connection is not shown or noted, this Contractor shall extend and connect the existing circuit as required.

2. In areas where the general construction work interrupts the continuity of an existing circuit, this Contractor shall relocate portion of the circuit required to maintain continuity.

D. Coordination: Coordinate all demolition work with the other trades and the Department.

3.4 EXISTING PANELBOARDS (Where Applicable)

A. Existing panelboards to remain or to be relocated:

1. Clean interiors and exteriors.

2. Inspect for damage. Notify Engineer if repairs are necessary or damaged components need replacing.

3. Tighten conduit and wire terminations in accordance with applicable codes.

B. Verify panelboards and panelboard feeders are of adequate capacity for loads to be served.

1. Activate loads connected to panelboards to achieve full load condition.

2. Measure and record amperage readings of phase and neutral conductors of panelboard feeders.

3. Provide typewritten report of recorded measurements to the Engineer for review.

C. Provide new typewritten circuit directory.

D. New circuit breakers for existing switchboards, panelboards or loadcenters shall match the existing circuit breaker type, manufacturer, and AIC rating. If the existing breaker type is no longer available, submit proposed substitution to Engineer for approval.

3.5 EXISTING WIRING

A. Inspect existing wiring which is to be disturbed for damage. Repair or replace damaged wiring.

B. Insure integrity of existing wiring insulation:

1. Megger wiring phase-to-phase, phase to neutral, phase to ground, and neutral to ground.

2. Record megger results. Provide typewritten report of results to the Engineer for review.

3. Repair defective insulation to a dielectric value equal to that of wire of the same type and age.

C. Secure and label existing wiring which is to be disturbed.

D. Tighten existing wiring terminations and connections in accordance with applicable codes.

3.6 EQUIPMENT CONNECTION

A. Refer to Section 260510, Electrical Equipment Wiring, for mechanical equipment wiring requirements.

B. Terminate all circuits feeding equipment or furniture in safety switch, receptacles or outlet as shown on the drawings or as directed by the Department.

C. Each piece of equipment requiring electric service shall be provided with a finished outlet.

D. Make final connections to each piece of equipment requiring electric service.

E. The drawings show generally the location of electric service to each piece of equipment. However, this contractor shall secure detailed shop drawings showing dimensioned locations for electric service to each piece of equipment from various contractors supplying such equipment prior to roughing-in.

F. This contractor will be required to relocate any misplaced outlet at his own expense if he fails to secure detailed shop drawings prior to roughing-in for equipment.

3.7 SPLICES

A. Splices shall be made with approved type solder-less connectors of the insulated type. However, at locations where the non-insulated type are used, they shall be covered with rubber and friction tape to the same thickness as the original insulation of the wire used. Solder-less connections shall be as manufactured by AMP Incorporated, Thomas & Betts, Burndy or approved equal.

3.8 TERMINAL AND CONNECTORS

A. All lugs, terminal blocks, etc. for panelboards, enclosed circuit breakers, switches, control centers, etc., shall be standard product as manufactured by AMP Incorporated, Thomas & Betts, Burndy or approved equal.

3.9 BALANCING

A. Each system of feeder and branch circuits for power and lighting shall be connected to panelboard buses in such a manner that loads connected thereto will be balanced on all phases as closely as practicable. Should there be any unfavorable condition of balance on any part of the electrical system, the Electrical Contractor shall make changes to the electrical system that may be required by the Department to remedy the unbalanced condition. Should there be an unbalance on existing equipment, not included under this contract, the contractor shall report the unbalance to the Department so that the condition may be corrected by the Department under a separate contract. Before final acceptance by the Department, the contractor shall submit readings of all phase legs at each panel with the lighting and power circuits "on". All conductors for the system shall be connected in strict accordance with the requirements of the National Electrical Code.

3.10 PIPE CURBS; EQUIPMENT SUPPORTS AND FLASHING

A. Coordinate installation of curbs, equipment supports, and flashing with the roofing work.

B. Minimum curb and support height shall be 12 inches.

C. Flash and counter flash where electrical conduit and equipment passes through weather or waterproofed walls, floors and roofs.

3.11 EXCAVATION AND BACKFILLING

A. Refer to Division 31 for requirements.

B. The contractor shall do all necessary excavating of widths and to depths required for the installation of manholes, box pads, concrete foundation slabs, for the installation of underground duct banks, and for the installation of other equipment and materials as shown on the drawings and herein specified.

C. Final grading, finishing, paving and seeding at all excavated areas shall be included under this contract, except where new surfaces are being provided as a part of the site work under the

General Contract. The Electrical Contractor will be responsible for all backfilling and paving of roadways, sidewalks and other paved areas associated with this contract. All surfaces shall be restored to the satisfaction of the Department.

D. Prior to submitting his bid price and prior to any work, the Electrical Contractor shall familiarize himself with local ordinances and amendments and shall contact the appropriate authorities to obtain all regulations and requirements that must be followed. The contractor shall secure all necessary permits before the start of any work.

E. Conform to Act No. 287 of the General Assembly of the Commonwealth of Pennsylvania that was enacted to protect the public health and safety.

F. The bottoms of all excavations shall be properly leveled off and concrete placed on undisturbed soil. All loose materials shall be removed and the excavations shall be brought into approved condition to receive concrete or other material. No earth filling shall be allowed under any bases or slabs. All excavation shall be carried down to firm formation. However, if additional depths are required to reach firm earth, the extra excavation and materials required to perform the work shall be done at no extra cost to the Department. If, through an error on the part of the contractor, any part of the excavation is carried below the depth indicated or required for the work, the contractor shall maintain the excavation and shall start concrete from the excavated level, and no extra compensation will be considered. Excavate and pour concrete only on the basis of approved shop drawings. Excavation below footings shall be filled with concrete as directed by the Department.

G. Notify the Department as soon as excavations are completed, in order that the bearing quality of the bottoms may be inspected before concrete is poured, or before formwork is erected. Concrete shall be poured as soon as weather conditions permit after excavation is completed and inspected. In case bottoms of excavations become wet and soft, all soft material shall be removed and the concrete poured to the required extra depth, at no extra cost to the Department.

H. Minimum cover for the various lines shall be not less than indicated on the drawings, but not less than local regulations and practice. Generally, piping shall be installed with not less than 3'-0" cover.

I. The width of all trenches shall be not less than widths shown on the drawings or required to install piping and materials.

J. The excavation shall be kept safe at all times. Shoring and sheathing shall be used when necessary. The excavation shall be kept free of water at all times. Additional shoring and sheathing may be ordered at any time to safeguard the work. Shoring and sheathing shall be provided in strict accordance with all applicable State, county and local ordinances and regulations.

K. All excess excavated materials shall be disposed of as directed by the Department. The number of points at which the contractor will be permitted to work and length of open trenches that will be permitted will be governed by the Department.

L. No existing asphalt or concrete paving shall be buried or otherwise disposed of on the site. It shall be disposed of off-site, by the contractor, in a manner consistent with applicable laws and regulations.

M. To protect persons from injury and to avoid property damage, adequate barricades, construction signs, torches, red lanterns, and guards shall be placed and maintained during the progress of construction, and until it is safe for traffic use. Rules and regulations of the local authorities respecting safety provisions will be observed.

N. Adequate protection shall be provided for all new or existing structures, services, or utilities encountered in the excavation. The protection shall include bracing, sheathing, supports, etc., as required to maintain grade and alignment and to provide proper mechanical strength. Any structures, services, or utilities damaged by the work of the contractor shall be promptly repaired and replaced in same condition as they originally were prior to such damage.

O. Any existing services, utilities or other obstructions no longer required, shall be removed where encountered during the excavation.

P. Excavation shall be conducted in a manner to cause the least interruption of traffic. Where traffic must cross open trenches, the contractor shall provide bridges suitable for the traffic involved.

Q. The proposal shall include all excavation that may be necessary to complete the project, including any rock that may be encountered. No blasting of any kind will be permitted on the interior or exterior of the building.

R. After the pipe or equipment has been laid, tested, inspected and concrete has been poured, cured and inspected, the excavation shall be backfilled by the contractor with the best carefully selected materials free from stones, large pebbles, hard lumps or frozen earth. The backfilling shall be placed in horizontal layers not to exceed 6" in thickness and each layer shall be thoroughly consolidated and compressed with pneumatic rammers. No backfilling shall be done until all undermined earth has been broken down and the sides of the excavation made vertical or inclined outward. New backfill shall be obtained on the site where necessary and where directed by the Department, or where necessary, backfill shall be hauled from off-site locations at no additional cost to the Department.

S. Restore the surfaces of all excavations to their original condition. This shall include existing or new paved or unpaved streets, parking areas, driveways, sidewalks, and turf. Existing trees, shrubs, or turf damaged under this contract shall be replaced to the satisfaction of the Using Agency and the Department.

T. As the work progresses, record on the drawings all changes and deviations from the contract drawings. Measurements shall include elevations and sufficient offset measurements from building to definitely locate all equipment and underground lines. Two prints of the marked drawings shall be delivered to the Department before final acceptance.

U. Any settling, deterioration or washing out of earth or repaired surfaces after initial installation shall be corrected by this contractor.

3.12 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Supporting devices for electrical components.

2. Concrete bases.

3. Electrical demolition.

4. Cutting and patching for electrical construction.

5. Touchup painting.

B. This Contractor shall furnish the services of an experienced superintendent who shall be constantly and continuously in charge of the installation of work.

C. The quality of the workmanship required for this trade in the execution of its work shall be of the finest and highest obtainable in that trade working with materials specified. Workmanship shall be accomplished to the satisfaction of the Department.

3.13 CORE DRILLING

A. This Contractor shall core drill holes associated with new feeders and branch circuits as indicated on the drawings.

B. All core drillings shall be fire stopped/sealed after installation of conduits as hereinafter specified.

C. This Contractor shall cover all equipment on the floor below core drillings. Any water or other damage shall be the responsibility of this Contractor to repair or replace without additional expense to the Department.

3.14 CUTTING AND PATCHING

A. Refer to Division 1 - General Requirements.

B. This Contractor shall be responsible for all cutting, patching, and finishing of existing construction for the proper installation of all electrical equipment and materials to be installed in the building. This will also be required for the removal of the existing equipment and materials. All cutting shall be kept to a minimum consistent with the requirements of the project. Cutting, patching, and finishing shall be done by workmen skilled in this type of work. All patching shall be done utilizing materials of the same quality and texture as the adjacent undisturbed areas perfectly and to the satisfaction of the Department. Painting of the final disturbed areas, where general construction work occurs, will be the responsibility of the General Contractor, unless otherwise indicated. Painting of the final finished areas, where no general construction work occurs, shall be by this Contractor. Be it walls or ceilings, paint entire plane in which damage occurs.

C. No cutting shall be done which may affect the building structurally or architecturally without first securing the approval of the Department. Cutting shall be accomplished in such a manner as not to cause damage to the building or leave unsightly surfaces, which cannot be concealed by plates, escutcheons or other construction. Where such unsightly conditions are caused, this Contractor shall be required, at his own expense, to repair the damaged areas.

D. Where openings are to be made in existing roof, obtain bonding company approval, if roof bond is still in effect, before such openings are made. Perform finishing and roof flashing, in areas of existing building or roof not being disturbed under general construction, for installation of work under Divisions 26, 27 and 28.

E. Cutting of the construction excessively or carelessly done shall be repaired by this Contractor to match the original work and to the satisfaction of the Department who will make the final decision with respect to excessive or careless cutting work.

F. This Contractor shall seal all openings he has made in plenum spaces, fire rated floors, ceilings or partitions after his work has been installed. The materials used for sealing the openings shall have a fire rating equal to or greater than the rating of the floor, ceiling or partition material.

G. Where present equipment is removed and unused openings remain in walls, floors, partitions, etc., this Contractor shall properly patch all such openings. All patching and repairing shall be done by workmen skilled in this type of work and shall match present or new finishes.

3.15 CLEANING

A. Refer to the General Conditions of the Contract.

B. Prior to painting, clean as required to remove plaster, dirt, grease, dust, labels, burrs, etc.

C. Prior to final inspection, the Contractor shall clean all equipment and surfaces within the scope of the project (for example: lighting fixtures, switch and receptacle plates, engine generators, electrical distribution equipment, etc.). In addition, the Contractor shall clean anything else that requires cleaning as a result of the Contractor's work.

D. Any damage in the electrical system or other damage to any part of the building, its finish or furnishings, due to failure to properly clean electrical equipment and or associated components, shall be repaired by the Contractor with no additional cost to the Department.

3.16 REFINISHING AND TOUCH UP PAINTING

A. Refinish and touch up paint.

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.

B. Conduit and equipment to be painted: Clean all conduit exposed to view in completed structure by removing plaster and dirt. Remove grease, oil and similar material from conduit and equipment by wiping with clean rags and suitable solvents in preparation for paint.

3.17 MOUNTING HEIGHTS

A. In addition to careful review of the electrical drawings, this Contractor shall refer to all applicable details, plans, etc. and perform a site survey to determine exact positioning of electrical, telephone, data, television, video, etc. outlets prior to installations. Unless otherwise specifically instructed, centerline-mounting heights of outlets and other equipment shall be located as follows:

1. Local Lighting Control Switches: Locate all outlets for single or gang switches 48" (top of box) above finish floor on strike side of door. If this location is such that it places the switch group partly in tiles or other finishes, the outlet shall be lowered sufficiently to bring the plate entirely on a flat surface (verify with Department before lowering outlet).

2. Convenience Outlets: 18" above finished floor except as otherwise noted.

3. Telecommunications Outlets: 18" above finished floor except as otherwise noted. Outlets for wall phones shall be located 60” above finished floor or as directed.

4. CATV Outlets: 18" above finished floor except as otherwise noted. Coordinate locations for wall-mounted televisions with Architectural details and features.

5. Outlets Above Countertops: 8" above top of counter without backsplash or 6" above top edge of backsplash except as otherwise noted.

6. Blank Outlets: Coordinate location with served equipment manufacturers shop drawing and installation details for service connection point of access except as otherwise noted.

7. Where similar types of outlets/devices are indicated on the drawings as being installed adjacent to each other on the same wall or in the same general area, but are indicated above as having different mounting heights, all similar outlets/devices shall be installed at the same mounting height. In such situations, confirm the mounting height with the Department.

8. Fire Alarm Pull Stations: 48" above finished floor to top of box.

9. Fire Alarm Audio/Visual and Visual Only Devices: The lower of 80" above finished floor (bottom of box) or 6" below ceiling (top of box).

10. All fire alarm pull stations and audio/visual devices shall be installed on same vertical centerline.

11. Safety Switches: 4’ above finished floor, except as otherwise noted.

12. Suspended Fixtures: As shown on drawings, as scheduled or as directed by the Department.

END OF SECTION

SECTION 260510

ELECTRICAL EQUIPMENT WIRING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 SECTION INCLUDES

A. Mechanical Equipment wiring, and General Equipment wiring.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Products are specified within Divisions 26, 27, and 28 Sections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The General, HVAC and Plumbing Contractors shall furnish all motors, starters, pushbuttons for local and remote control, controllers, pressure switches, aquastats or similar items together with all appurtenances, accessories and control wiring required to operate the equipment furnished under their respective sections of the contract, which is necessary to perform the operating functions as specified, shown on the drawings, or as otherwise required.

B. The General, HVAC and Plumbing Contractors shall set and mount all motors, starters, and controls. This Contractor shall furnish and install all safety switches at the equipment and make all power connections to the safety switches, starters, and the motors. All control wiring necessary for the required performance and operation of the equipment shall be installed and connected under each respective and associated contract. Where the starter and/or safety switch is an integral part of the equipment assembly, the assembly shall be furnished with the wiring being complete between the starter, controller and motor and this Contractor shall make the power connections only at the unit.

C. If procurement requirements necessitate a change in the electrical characteristics of any motor or equipment being furnished under the General, HVAC or Plumbing Contract, the respective Contractor shall first obtain approval of such changes from the Department. The same Contractor shall also be responsible for all necessary arrangement and shall pay all costs, if any, for all required changes to this contract.

3.2 GENERAL REQUIREMENTS

A. This Contractor shall furnish, install, and connect all power wiring to all equipment and all associated controls and appurtenances provided under this section of the contract. In addition, this Contractor shall furnish, install, and connect all power wiring to all equipment, associated controls and appurtenances provided under other sections of this contract, unless otherwise specified herein or indicated on the drawings. All necessary and required control wiring for the aforementioned equipment, and systems shall be furnished, installed and connected by the respective Contractors providing the equipment, unless otherwise specified herein or indicated on the drawings.

3.3 WIRING FOR HEATING, VENTILATING AND AIR CONDITIONING

A. All equipment for the heating, ventilating and air conditioning systems shall be furnished and installed under the HVAC Contract, unless otherwise indicated.

B. This Contractor shall be responsible for furnishing all labor and materials required for the installation and connection of all electrical power wiring to and for the HVAC equipment, unless otherwise indicated.

C. In general, all starters and special control equipment required for the heating, ventilating and air conditioning equipment such as the unit heaters, air handling units, etc., will be furnished and installed under the temperature control section of the HVAC Contract, unless otherwise indicated.

3.4 TEMPERATURE CONTROL WIRING

A. All interconnecting control wiring associated with the temperature control system(s) for heating and air conditioning system(s) shall be furnished, installed, and connected under the HVAC Contract.

B. This Contractor shall provide a source of power and make final power connections for all temperature control system equipment (air handling units, etc.) and at each apparatus control panel location. Temperature Control Panels shall be furnished and installed under the HVAC Contract.

3.5 ELECTRICAL WORK FOR ROOF VENTILATORS AND/OR EXHAUST FANS

A. For single-phase units, a motor starting disconnecting type snap switch shall be furnished as an integral part of the roof ventilator or exhaust fan. However, this Contractor shall furnish a remote-control thermal overload switch with pilot light. Switch shall be installed within the room to be ventilated or exhausted, as indicated on the drawings but generally adjacent to unit.

B. For 3-phase units, this Contractor shall furnish and install remote control switches, together with pilot lights, within the room to be ventilated or exhausted at location as indicated on the drawings. In addition, the Contractor shall furnish and install a disconnect switch (in proper NEMA rated enclosure) at motor location.

3.6 WIRING FOR PLUMBING EQUIPMENT

A. All equipment for the plumbing system shall be furnished and installed under the Plumbing Contract, unless otherwise indicated.

B. This Contractor shall be responsible for furnishing all labor and materials required for the installation and connection of all electrical power wiring to and for the Plumbing equipment, unless otherwise indicated.

C. In general, all starters and special control equipment required for electrically operated equipment furnished under the Plumbing Contract, such as the pumps and electric water heaters will be furnished and installed by the Plumbing Contractor.

3.7 ELECTRICAL EQUIPMENT BY OTHERS

A. All electrical equipment furnished and installed under contracts other than this contract shall be furnished with full complement of control equipment, control wiring, conduit, and all other items necessary for satisfactory operation.

B. Remote motor starters for equipment furnished under contracts other than this contract shall be furnished and installed by the respective Contractor providing the equipment.

C. This Contractor shall furnish and install fused disconnect switches, to include properly rated and type of fuses, for all 3-phase equipment unless otherwise indicated.

D. This Contractor shall furnish and install thermal overload switches for each single-phase motor except where units are furnished with built-in thermal protection, in which case this Contractor shall furnish and install a single pole switch, with or without pilot light as indicated on the drawings or directed by the Department.

E. This Contractor shall complete all power wiring through the disconnect switch and/or thermal cutouts and local control stations to the equipment as required.

F. This Contractor shall complete all electrical connections, through the disconnect switch, starter, and motor terminals of all 3-phase equipment. This Contractor shall be responsible for final connections.

G. This Contractor shall be responsible for proper direction of rotation of 3-phase motors.

H. This Contractor shall provide disconnect switches for all 3-phase equipment. Combination motor starter/disconnect switches shall be furnished and installed under the contracts providing the equipment. This Contractor shall provide disconnect switches at motors when motors are located away from combination starter/disconnect switches.

3.8 LOCATIONS

A. This Contractor shall apply for detailed and specific information regarding the location of all equipment as the final location may differ from that indicated on the drawings. Outlets, equipment or wiring improperly placed because of this Contractor's failure to obtain this information shall be relocated and reinstalled without additional expense to the Department.

B. The design shall be subject to such revisions as may be necessary to overcome building obstructions. No changes shall be made in location of outlets or equipment without written consent of the Department.

C. This Contractor is cautioned that all outlet information must be checked and verified before installation; and all stub-ups into equipment must be as indicated and detailed on the respective shop drawings.

D. Unless otherwise detailed on the drawings, rough-in of proper size and capacity of mechanical equipment indicated on the drawings as “Future” or “N.I.C.” shall be provided and installed in such a manner and location that future final connections can be made with a minimum of work and without cutting or patching permanent walls, partitions, ceiling or floors.

E. Engineering drawings are, of necessity, schematics for special equipment as exact roughing-in and requirements may vary with different manufacturers. Each trade shall connect its respective services to all special equipment indicated on the drawings at no additional cost to the Department.

END OF SECTION 260510

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:

1. Building wires rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections include the following:

1. Division 27 Section "Communications Horizontal Cabling” for cabling used for voice and data circuits.

1.4 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

1.6 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.

1.7 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

PART 3 - CONDUCTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

3.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 4 - EXECUTION

4.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

4.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. Class 1 Control Circuits: Type THHN-THWN, in raceway.

J. Class 2 Control Circuits: Type THHN-THWN, in raceway.

4.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls and ceilings unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

4.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

4.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

4.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Retain first paragraph and subparagraphs below to describe tests and inspections to be performed by either of the entities in two paragraphs above.

C. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.

   a. Panel board Feeders.
   b. Branch-circuit conductors

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

END OF SECTION 260519

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.

C. Field quality-control test reports.

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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators. Minimum 12" long, predrilled and/or punched.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 5/8-inch in diameter by 8 feet in length.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.

1. Bury at least 30 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
3. Tracer (independent of trench tape): #12 THHN CU buried 12" below finished rough grade along trench for tracing capabilities.

B. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
3. Cal Lab ground bars: Provide ground conductors in EMT and shall leave wall via 4”x4” flush mounted box with 90 degree cable fitting. Conceal ground conductor in as much as possible. Closely coordinate all blocking requirements in the walls with the G.C. prior to drywall installation.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Pad-Mounted Transformers: Install four ground rods (one at each corner) and ground ring around the vault. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor (or as otherwise directed) 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 grounding bus with standoff insulators.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

D. Specialized gas piping: ground all gas piping as per NEC and manufacturer’s recommendations.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor (or as otherwise directed).

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart. Provide 4/0 AWG copper from in-slab rebar to each column as per NEC.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal**,** at ground test wells. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
2. Pad-Mounted Equipment: 5 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

D. Provide a complete, detailed grounding report with all measured ground resistances.

END OF SECTION 260526

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.4 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. Thomas & Betts Corporation.
e. Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Hilti Inc.
3) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To New Concrete: Bolt to concrete inserts.
2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
3. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
4. To Light Steel: Sheet metal screws.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

1.4 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

C. Samples: For surface raceways and for each color and texture specified, 12 inches (300 mm) long.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. GRC: Comply with ANSI C80.1 and UL 6.
3. IMC: Comply with ANSI C80.6 and UL 1242.
4. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

    a. Comply with NEMA RN 1.
    b. Coating Thickness: 0.040 inch (1 mm), minimum.

5. EMT: Comply with ANSI C80.3 and UL 797.
6. FMC: Comply with UL 1; zinc-coated steel.
7. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Comply with NEMA FB 1 and UL 514B.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fittings, General: Listed and labeled for type of conduit, location, and use.
4. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
5. Fittings for EMT:

    a. Material: Steel.
    b. Type: Compression.

6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Fiberglass:

    a. Comply with NEMA TC 14.
    b. Comply with UL 2515 for aboveground raceways.
    c. Comply with UL 2420 for belowground raceways.

3. ENT: Comply with NEMA TC 13 and UL 1653.
4. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
5. LFNC: Comply with UL 1660.
6. Rigid HDPE: Comply with UL 651A.
7. Continuous HDPE: Comply with UL 651A.
8. Coilable HDPE: Preassembled with conductors or cables and complying with ASTM D 3485.
9. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:

1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

    a. Fittings for LFNC: Comply with UL 514B.

3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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

C. Wireway Covers: Hinged type unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

D. Tele-Power Poles:

1. Material: Aluminum with clear anodized finish.
2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

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

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Metal Floor Boxes:

1. Material: sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb. (23 kg) shall be listed and marked for the maximum allowable weight.

G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb. (32 kg).

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

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

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).

K. Gangable boxes are allowed.

L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC" or as indicated.

6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of fiberglass.

1. Standard: Comply with SCTE 77.
2. Color of Frame and Cover: Green.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC" or as indicated
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long (300 mm Wide by 600 mm Long) and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: GRC.
3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried or concrete encased.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: IMC. Raceway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

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

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

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. 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.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches (300 mm) of enclosures to which attached.

L. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to GRC before rising above floor.

M. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

S. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

T. Cut conduit perpendicular to the length. For conduits 2-inch (53-mm) trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

U. 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. Cap underground raceways designated as spare above grade alongside raceways in use.

V. Surface Raceways:

1. Install surface raceway with a minimum 2-inch (50-mm) radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

W. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

X. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C) and that has straight-run length that exceeds 25

feet (7.6 m). Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
    d. Attics: 135 deg F (75 deg C) temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

EE. Locate boxes so that cover or plate will not span different building finishes.

FF. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

HH. Set metal floor boxes level and flush with finished floor surface.

II. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits but a minimum of 6 inches (150 mm) below grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes with bottom below frost line, 36” below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260500."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification for conductors.
3. Underground-line warning tape.
4. Equipment identification labels.
5. Miscellaneous identification products.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.6 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: COMMUNICATIONS CABLE.

C. Tag: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

2.4 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

F. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Normal Emergency.

2. Standby.
3. Telecom.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

D. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Self-adhesive, engraved, melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.
b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
c. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.

c. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
d. Enclosed switches.
e. Enclosed controllers.
f. Receptacles (circuit number)
g. Switches (circuit number)

END OF SECTION 260553

SECTION 260573

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. This Section includes computer-based, fault-current, overcurrent protective device coordination, and ARC Flash studies. Protective devices shall be set based on results of the protective device coordination study.

1. Series-rated devices are not permitted.
2. The Electrical Contractor shall be responsible for performing all recommendations, adjust settings, adjust type and style of protective devices as required in the Overcurrent Protective Device Coordination Study and the Fault Current Study at no additional cost to the owner.

1.3 SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report.

1.4 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:

1. CGI CYME.
2. EDSA Micro Corporation.
3. ESA Inc.
4. Operation Technology, Inc.
5. SKM Systems Analysis, Inc. (preferred)

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. All electrical distribution devices, standby generator, automatic transfer switches, and branch breakers shall be coordinated.

1. Proceed with coordination study only after relevant equipment submittals have been assembled.
2. Submit coordination study with all coordination of protective devices already accomplished with the various other submittals prior to submitting.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation

tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.
    c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    d. Generator kilovolt amperes, size, voltage, and source impedance.
    e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    f. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
    c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
    d. Generator thermal-damage curve.
    e. Ratings, types, and settings of utility company's overcurrent protective devices.
    f. Special overcurrent protective device settings or types stipulated by utility company.
    g. Time-current-characteristic curves of devices indicated to be coordinated.
    h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
    i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
    j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

    1. Distribution panelboard.
    2. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:

    a. ANSI C57.12.10.
    b. ANSI C57.12.22.
    c. ANSI C57.12.40.
    d. IEEE C57.12.00.
    e. IEEE C57.96.

2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

    a. Inrush current when first energized.
    b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.
   e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

3.5 ARC FLASH STUDY

A. Provide a comprehensive ARC Flash study for all major equipment. Provide suitable Arc Flash labels meeting the requirements of the NEC.

END OF SECTION 260573

SECTION 260923

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following lighting control devices:

1. Time switches.
2. Outdoor photoelectric switches.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

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.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PRODUCTS

1.7 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Intermatic, Inc.
2. Leviton Mfg. Company Inc.
3. Paragon Electric Co.; Invensys Climate Controls.
4. Square D; Schneider Electric.
5. TORK.

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.

1. Contact Configuration: SPST.
2. Contact Rating: 20-A ballast load, 277-V ac**.**
3. Programs: 2 channels; each channel shall be individually programmable with 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
5. Astronomic Time: All channels.
6. Battery Backup: For schedules and time clock.

1.8 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Grasslin Controls Corporation; a GE Industrial Systems Company.
3. Intermatic, Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.
5. Novitas, Inc.
6. Paragon Electric Co.; Invensys Climate Controls.
7. Square D; Schneider Electric.
8. TORK.
9. Touch-Plate, Inc.
10. Watt Stopper (The).

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

C. Description: Solid state, with SPST dry contacts rated for 1800 VA to operate connected load, relay, or contactor coils; complying with UL 773.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
2. Time Delay: 30-second minimum, to prevent false operation.
3. Lightning Arrester: Air-gap type.
4. Mounting: Twist lock complying with IEEE C136.10, with base.

PART 2 - EXECUTION

2.1 WIRING INSTALLATION

A. Wiring Method: Minimum conduit size shall be 3/4 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

2.2 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

2.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

END OF SECTION 260923

SECTION 261200

MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries:

1. Pad-mounted, liquid-filled transformers.

1.4 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.5 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

B. Shop Drawings: Diagram power wiring.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Follow-up service reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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 IEEE C2.

D. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.

E. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or an approved equal:

1. Cutler-Hammer.
2. GE Electrical Distribution & Control.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric.

2.2 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

A. Description: ANSI C57.12.13, IEEE C57.12.00, pad-mounted, 2-winding transformers. Stainless-steel tank base and cabinet.

B. Insulating Liquid: Mineral oil, complying with ASTM D 3487, Type II, and tested according to ASTM D 117.

C. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.

D. Basic Impulse Level: 95 kV.

E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

F. High-Voltage Switch: 200A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for loop feed with 3-phase, 4-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.

G. Primary Fuses: 150-kV BIL fuse assembly with fuses complying with IEEE C37.47.

1. Bay-O-Net liquid-immersed current-limiting fuses that are externally replaceable without opening transformer tank.

H. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have three arresters for loop-feed circuits.

I. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:

1. Bushing-Well Inserts: One for each high-voltage bushing well.
2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
3. Parking Stands: One for each high-voltage bushing well, located so as not to interfere with maintenance.
4. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

J. Accessories:

1. Drain Valve: 1 inch (25 mm), with sampling device.
2. Dial-type thermometer.
3. Liquid-level gage.
4. Pressure-vacuum gage.
5. Pressure Relief Device: Self-sealing with an indicator.
6. Mounting provisions for low-voltage current transformers.
7. Mounting provisions for low-voltage potential transformers.
8. Busway terminal connection at low-voltage compartment.
9. Alarm contacts for gages and thermometer listed above.

2.3 IDENTIFICATION DEVICES

A. Nameplates: The unit shall come complete with a stamped manufacturer’s identification plate riveted to the outside of the secondary side door which is identical to the one on the interior of unit. Labels will not be acceptable.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.50.

B. Factory Tests: Perform the following factory-certified tests on each transformer:

1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
2. Ratios on rated-voltage connection and on tap extreme connections.
3. Polarity and phase relation on rated-voltage connection.
4. No-load loss at rated voltage on rated-voltage connection.
5. Excitation current at rated voltage on rated-voltage connection.
6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
7. Applied potential.
8. Induced potential.
9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.

a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Install transformers on prefabricated concrete vault.

1. Anchor transformers to vault according to manufacturer's written instructions, seismic codes at Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

3.4 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following field tests and inspections and prepare test reports:

1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Test Reports: Prepare written reports to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

END OF SECTION 261200

SECTION 262213

LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section includes distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Match manufacturer of panelboards.

B. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event."

2.3 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.4 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure.

D. Coils: Continuous windings without splices except for taps.

1. Coil Material: Aluminum.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Bolted.

E. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

F. Enclosure: Ventilated.

1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Finish: Comply with NEMA 250.

    a. Finish Color: Gray weather-resistant enamel.

G. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

J. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

K. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 80 deg C rise above 40 deg C ambient temperature.

L. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

M. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
2. Indicate value of K-factor on transformer nameplate.
3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.

N. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

O. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

P. Wall Brackets: Manufacturer's standard brackets (if applicable).

Q. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:

1. 9.00 kVA and Less: 40 dBA.
2. 9.01 to 30.00 kVA: 45 dBA.
3. 30.01 to 50.00 kVA: 45 dBA for K-factors of 1, 4, and 9/48 dBA for K-factors of 13 and 20.

2.5 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
2. Ratio tests at rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:

    a. High-voltage to ground.
    b. Low-voltage to ground.
    c. High-voltage to low-voltage.

9. Temperature tests.

B. Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

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

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer (if applicable).

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to standard practice and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall be as follows.

2. Concrete shall be 3000PSI, 4” deep, metal mesh reinforced, and pinned to the existing concrete slab with #4 rebar epoxied into existing concrete floor at least 4” and shall penetrate new foundation at least 2”. Concrete foundation shall extend 4” past dimensions of transformer and have a broom finish.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

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-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection.

    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, and grounding.
    c. Verify that resilient mounts are free and that any shipping brackets have been removed.
    d. Verify the unit is clean.
    e. Perform specific inspections and mechanical tests recommended by manufacturer.
    f. Verify that as-left tap connections are as specified.
    g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

    a. Measure resistance at each winding, tap, and bolted connection.
    b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
    c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
    d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

D. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify the unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Measure resistance at each winding, tap, and bolted connection.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
c. Perform power-factor or dissipation-factor tests on all windings.
d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
e. Perform an excitation-current test on each phase.
f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

E. Remove and replace units that do not pass tests or inspections and retest as specified above.

F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Distribution panel boards.
2. Lighting and appliance branch-circuit panel boards.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
    b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet (2000 m).

1.8 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Surface-mounted and flush-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.

4. Directory Card: Inside panelboard door, mounted in transparent card holder.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square-D

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

C. Main Overcurrent Protective Devices: Circuit breaker, unless noted otherwise on panelboard schedule, electronic trip, fully adjustable. All settings shall be coordinated with the short circuit/coordination study prior to shop drawing submittal. Submit panelboard and short circuit/coordination study at the same time.

D. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square-D

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

C. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

D. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

H. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262713

ELECTRICITY METERING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section includes equipment for electricity metering by utility company and electricity metering requested by Owner.

1.4 DEFINITIONS

A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

B. PC: Personal computer.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For electricity-metering equipment.

1. Dimensioned plans and sections or elevation layouts.
2. Wiring Diagrams: For power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features.

C. Operation and Maintenance Data. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.

2. Software licenses.
3. Software service agreement.
4. Hard copies of manufacturer's operating specifications, design user's guides for software and hardware, and PDF files on CD-ROM of the hard-copy Submittal.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Receive, store, and handle modular meter center according to NECA 400.

1.8 COORDINATION

A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:

1. Comply with requirements of utilities providing electrical power services.
2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

1.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade his computer equipment if necessary.
2. All licenses shall be at no additional cost to the owner and shall be open ended and unrestricted use.
3. All passwords must be coordinated with DMVA prior to establishing such.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING REQUESTED BY OWNER

A. Manufacturers: Provide one of the following:

1. Square D Power Logic Model 5560 (no substitutions).

B. General Requirements for Owner's Meters:

1. Comply with UL 1244.

2. Meters used for data collection shall have an accuracy of 0.2 percent of reading, complying with requirements in ANSI C12.20.
3. Enclosure: NEMA 250, Type 3R minimum., manufacturer's recommended enclosure with clear panel for readings without opening doors. Provide with hasp for padlocking or sealing.
4. Identification: Comply with requirements in Division 26 Section "Identification for Electrical Systems."
5. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
6. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

    a. Type: Split core.

7. Current-Transformer Cabinet: Listed or recommended by metering equipment manufacturer for use with sensors indicated.
8. Building Automation System (BAS) Interface: One digital KY pulse to a user-definable increment of energy measurement. Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing and possible programmed demand control action by destination system.
9. The system must report data to the Johnson Metasys head end at FTIG, Bldg 11-64. Provide all software and hardware for proper data transmission. Coordinate points and data prior to shop drawing submittal.

C. Kilowatt-hour/Demand Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch (6 mm) high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand. Retain accumulated kilowatt-hour and historic peak demand in a nonvolatile memory, until reset.

D. Software: Preloaded by manufacturer. Loaded by means of cable into meter and is a product of meter manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters as per this specification. Provide all software, programming, and trouble- shooting necessary for proper operation. Install raceways and equipment according to utility company's written requirements. Provide conduits for metering leads and extend grounding connections as required by utility company.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Equipment Identification Labels: See “Identification for Electrical Systems”.

END OF SECTION 262713

SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Snap switches.
3. Cord and plug sets.

1.4 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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 NFPA 70.

1.7 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements and intended classification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5351 (single), 5352 (duplex).
b. Hubbell; HBL5351 (single), CR5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5381 (single), 5352 (duplex).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; GF20.
b. Pass & Seymour; 2084.

2.4 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Brushed stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, thermoplastic with lockable cover, rated weather-proof while in use.

2.7 FINISHES

A. Color: Gray.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates. All wall boxes shall be 4”x4” square with appropriate covers for type of installation (drywall, surface, etc.) This shall include receptacles, switches, and the like. Double duplex shall be multigang as necessary for proper installation.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and switches (to include wall box occ sensors, etc.): Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

END OF SECTION 262726

SECTION 262813

FUSES

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in enclosed switches and enclosed controllers.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.6 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels. Coordinate with coordination study recommended settings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Motor Branch Circuits: Class RK5, time delay.

3.3 INSTALLATION

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

B. Install plug-fuse adapters in Edison-base fuse holders and sockets. Ensure that adapters are irremovable once installed.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section Includes:

1. Fusible and non-fusible switches.

1.4 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

1.7 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE AND NON-FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses as required, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Lugs: Mechanical type, suitable for number, size, and conductor material.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install fuses in fusible devices as required.

C. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

END OF SECTION 262816

SECTION 263100

PHOTOVOLTAIC COLLECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. PV system description.
2. Manufactured PV units.
3. PV module framing.
4. PV array construction.
5. Combiners
6. Inverters.
7. System overcurrent protection.
8. Mounting structures.

1.3 DEFINITIONS

A. CEC: California Energy Commission.

B. ETFE: Ethylene tetrafluoroethylene.

C. FEP: Fluorinated ethylene propylene.

D. IP Code: Required ingress protection to comply with IEC 60529.

E. MPPT: Maximum power point tracking.

F. PTC: PVUSA Test Condition. Commonly regarded as a "real-world" measure of PV output. See below for definition of "PVUSA."

G. PV: Photovoltaic.

H. PVUSA: Photovoltaics for Utility Systems Applications.

I. STC: Standard Test Conditions defined in IEC 61215.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For PV modules.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Detail fabrication and assembly.
4. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special materials and workmanship warranty and minimum power output warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For PV modules to include in operation and maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.

1. Manufacturer's materials and workmanship warranties include, but are not limited to, the following:

a. Faulty operation of PV modules.
b. Panels must be rated at 85% of initial rated value in the 25^{th} year of service.

2. Warranty Period: 25 years from date of Substantial Completion.

B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.

1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:

    a. Specified minimum power output to 98 percent after one year, and not less than 85 percent after a period of 25 years.
    b. Provide Warranty certificate.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Mission Solar Energy: MSE425SX9Z or equivalent

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Hazardous Locations: FM Global approved for NFPA 70, Class 1, Division 2, Group C and Group D.

C. Seismic Qualification Certificates: For panels and racking, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

2.3 PV CAPACITIES AND CHARACTERISTICS

A. Minimum Electrical Characteristics per panel:

1. Rated Open-Circuit Voltage: 49 V dc.
2. Maximum System Voltage: 1000 V dc.
3. Maximum Power at Voltage (Vmp): 425 W.
4. Short-Circuit Temperature Coefficient: 0.043%/deg C.
5. Rated Short-Circuit Current (Isc): 11.1 A dc.
6. Rated Operation Current (Imp): 10.6 A dc.
7. Maximum Power at STC (Pmax): 435 watts.

B. Additional Electrical Characteristics:

1. PTC Rating: 425W.
2. Peak Power per Unit Area: 19 W/sq ft.
3. Tolerance of Pmax: 0/+3 percent.

4. Minimum Peak Power: 435.
5. Series Fuse Rating: 20 A.
6. Module Efficiency: 19.3 percent.
7. Temperature Operating Range: -40°F to 185°F
8. Relative Humidity: 0-95% percent RH (non-condensing).
9. Loading: 5400 Pa front and 3600 Pa back.
10. Hailstone Impact Withstand: 25 mm diameter at 23 m/s.
11. Series Fuse Rating: 20 A.

C. Normal Operating Temperature Characteristics (NOTC):

1. Temperature at Nominal Operating Cell Temperature: 46°C.
2. Temperature Coefficient (NOTC Nominal Power): -0.347%/°C.
3. Temperature Coefficient (NOTC Open-Circuit Voltage): -0.261%/°C
4. Temperature Coefficient (NOTC Short Circuit Current): 0.043%/°C

2.4 PV SYSTEMS DESCRIPTION

A. Interactive PV System: Collectors connected in parallel to the electrical utility; and capable of providing power for Project and supplying power to a distributed network.

1. Fifty, 20-module arrays to generate a total nominal rated output of 425 kW.
2. System Components:

a. PV modules.
b. Array frame.
c. Utility-interactive inverter(s).
d. Overcurrent protection, disconnect, and rapid shutdown devices.
e. Mounting structure.
f. Utility meter.

2.5 MANUFACTURED PV UNITS

A. Cell Materials: P-type Monocrystalline Silicon.

B. Module Construction:

1. Nominal Size: 41.5 inches (1054 mm) wide by 82.13 inches (2086 mm) long.
2. Weight: 51.6 lb (23.4 kg).

C. Encapsulant: Ethyl vinyl acetate.

D. Front Panel: Fully tempered glass.

E. Front Panel: 0.125-inch- (3.2-mm-) thick glass.

F. Front Panel: Low iron glass.

G. Front Panel: Antireflective coating glass.

H. Backing Material: Polyester film.
   1. Color: White.

I. Bypass Diode Protection: Internal.

J. Junction Box:

   1. Size: 1.56 by 3.96 by 0.52 inch (39.6 by 100.6 by 13.2 mm).
   2. Fully potted, vandal resistant.
   3. IP Code: IP67.

K. Output Cabling:

   1. 12 AWG (4 mm), 55 inch (1.4 meter) length.
   2. Quick, multiconnect, polarized connectors.

L. Series Fuse Rating: 20 A dc.

2.6 PV MODULE FRAMING

A. PV laminates mounted in anodized extruded-aluminum frames.

   1. Entire assembly UL listed for electrical and fire safety, Class A, according to UL 1703, and complying with IEC 61215.
   2. Frame strength exceeding requirements of certifying agencies in subparagraph above.
   3. Finish: Anodized aluminum.

      a. Alloy and temper recommended by framing manufacturer for strength, corrosion resistance, and application of required finish.
      b. Color: As indicated by manufacturer's designations.

2.7 PV ARRAY CONSTRUCTION

A. Framing:

   1. Material: Extruded aluminum, Galvanized steel, or Coated steel.
   2. Maximum System Weight: Less than 4 lb/sq. ft. (19.53 kg/sq. m).
   3. Minimum Distance to Connectors: 55 inches (1.4 m).
   4. Raceway Cover Plates: Aluminum or Galvanized steel.

2.8 INVERTER

A. Inverter Type: Distributed.

B. Control Type: Pulse-width-modulation control.

C. Control Type: Maximum power point tracker control.

D. Inverter Electrical Characteristics:

1. Maximum Recommended PV Input Power: 500 kW.
2. Maximum Open-Circuit Voltage: 1500 V dc.
3. PV Start Voltage: 750 V dc.
4. MPPT Voltage Range: 750-1450 V dc.
5. Maximum Input Current: 237.3 A.
6. Number of String Inputs: Dependent on number and type of combiners.
7. Number of Independent MPPT Circuits: 1.
8. Nominal Output Voltage: 480 V ac.
9. Maximum Output Current: 240.6 A ac.
10. Peak Efficiency: 99.0 percent.
11. CEC Weighted Efficiency: 98.5 percent.
12. CEC Night Tare Loss: <1 W.
13. DC Terminal Range (AWG): max 750kcmil, one or two conductor with lugs.
14. AC Terminal Range (AWG): max 600kcmil, one or two conductor with lugs.
15. Communications Interface: WiFi, Ethernet, Modbus TCP/IP.
16. Utility Interface: Utility-interactive inverter.

E. Operating Conditions:

1. Operating Ambient Temperatures: Minus 40°F to plus 140 °F (minus 40°C to plus 60°C).
2. Storage Temperature: Minus 40°F to plus 167 °F (minus 40°C to plus 75°C).
3. Relative Humidity: 0 to 95 percent, noncondensing.

F. Enclosure:

1. NEMA Type 3R.
2. Enclosure Material: Powder Coated Aluminum
3. Cooling Methods:

    a. Fan convection cooling.
    b. Passive cooling.

4. Protective Functions:

    a. AC over/undervoltage.
    b. AC over/underfrequency.
    c. Ground overcurrent.
    d. Overtemperature.
    e. AC and DC overcurrent.
    f. DC overvoltage.

5. Standard infographic panel to indicate a minimum of Ready, Network and Communication, Power, Maintenance, and Power Fault.

G. Disconnects: Rated for system voltage and conductor.

H. Regulatory Approvals:

1. IEEE 1547.1.

2. IEEE 1547.3.
3. UL 1741.

I. Characteristics:

1. Inverter Dimensions: 29.5 in H x 44.3 in W x 15.4 in D.
2. Inverter Weight: 290 lb.

2.9 COMBINER

A. Input fusing: Positive pole fused.

B. Input wiring Type: #14 – 4 AWG, PV Rated, copper wire only.

C. Inverter Electrical Characteristics:

1. Maximum Output Wire Compatibility: 1 Conductor at 750 kcmil or 2 Conductors at 500 kcmil.
2. Maximum Voltage: 1500 V dc.
3. DC Disconnect Current Rating: 400 A.
4. Number of String Inputs: 20.
5. Input Fuse Rating: 20 A.
6. Maximum Output Current: 400 A.

D. Operating Conditions:

1. Ambient Temperatures: Minus 40°F to plus 140 °F (minus 40°C to plus 60°C).
2. Operating Temperatures: Minus 40°F to plus 122 °F (minus 40°C to plus 50°C).
3. Storage Temperature: Minus 40°F to plus 167 °F (minus 40°C to plus 75°C).
4. Relative Humidity: 0 to 95 percent, noncondensing.

E. Enclosure:

1. Polyester Powder Coated Steel, NEMA Type 4.

2. Protective Functions:
   a. DC overcurrent.

F. Disconnects: Rated for system voltage and conductor.

G. Regulatory Approvals:
1. UL 1741.

H. Characteristics:

1. Combiner Dimensions: 30 in H x 24 in W x 8 in D.
2. Inverter Weight: 85 lb.

2.10 SYSTEM OVERCURRENT PROTECTION

A. Circuit Breakers: 350 A, in NEMA TYPE 3R enclosure for each inverter.

2.11 MOUNTING STRUCTURES

A. Ground Screw Mount: G115 Galvanized Steel with necessary adapters.

B. Mounting Channels: Vertical and horizontal channels with mounting points for Solar Panels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Do not begin installation until mounting surfaces have been properly prepared.

C. If preparation of mounting surfaces is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.

D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.

E. Examine supports, and supporting structures for suitable conditions where PV system will be installed.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of PV panels with support assembly and other construction.

C. Support PV panel assemblies independent of supports for other elements. Support assembly to prevent twisting from eccentric loading.

D. Install PV collector panels, combiners, inverters, rapid shutdown, and AC collection equipment in locations indicated on Drawings.

E. Seismic Restraints: Comply with requirements for seismic-restraint devices specified in Section 260548.16 "Seismic Controls for Electric Systems."

F. Wiring Method: Install cables in raceways.

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 CONNECTIONS

A. Coordinate PV panel cabling to equipment enclosures to ensure proper connections.

B. Coordinate installation of utility-interactive meter with utility.

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-486B.

D. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

END OF SECTION 263100

SECTION 265100

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 STIPULATONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

B. The specification Section 260500 – COMMON WORK RESULTS FOR ELECTRICAL forms a part of this section and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. This Section includes the following:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections include the following:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.4 DEFINITIONS

A. BF: Ballast factor.

B. CRI: Color-rendering index.

C. LER: Luminaire efficacy rating.

D. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.5 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast.
4. Energy-efficiency data.
5. Life, output, and energy-efficiency data for lamps.
6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
    b. Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program (NVLAP) for Energy Efficient Lighting Products.

B. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. 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 NFPA 70.

D. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

1.7 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-detection system, and partition assemblies.

1.8 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency LED Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Electronic Drivers: Manufacturer's standard form in which driver manufacturer agrees to repair or replace drivers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Drivers: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Basis-of-Design Product: The design for each lighting fixture is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

A. LED Fixtures: Comply with UL 1598. Where LED is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

F. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

    a. Lens Thickness: At least 0.125-inch (3.175 mm) minimum unless different thickness is indicated.
    b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS (if applicable)

A. Electronic Ballasts: Comply with ANSI C82.11; programmed-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.

1. Sound Rating: A.
2. Total Harmonic Distortion Rating: Less than 10 percent.
3. Transient Voltage Protection: IEEE C62.41, Category A or better.

4. Operating Frequency: 20 kHz or higher.
5. Lamp Current Crest Factor: 1.7 or less.
6. BF: 0.85 or higher.
7. Power Factor: 0.98 or higher.
8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Ballasts for Low-Temperature Environments:

1. Temperatures 0 Deg F and Higher: Electronic or electromagnetic type rated for 0 deg F starting and operating temperature with indicated lamp types.
2. Temperatures Minus 20 Deg F and Higher: Electromagnetic type designed for use with indicated lamp types.

2.4 EMERGENCY LED POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate 1 driver and array continuously at an output of 1400 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture driver.
2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
5. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.5 EXIT SIGNS

A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.

2.6 FLUORESCENT LAMPS (if applicable)

A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 82 (minimum), color temperature 3500 K, and average rated life 20,000 hours, unless otherwise indicated.

C. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 82 (minimum), color temperature 3500 K, and average rated life of 20,000 hours, unless otherwise indicated.

D. Compact Fluorescent Lamps: 4-Pin, low mercury, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at 3 hours operation per start, and where required, suitable for use with dimming ballasts, unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

C. Adjust aimable lighting fixtures to provide required light intensities.

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 265100

SECTION 311000

SITE CLEARING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.3 SUMMARY

A. This Section includes the following:

1. Protecting existing trees and grass to remain.
2. Removing above- and below-grade site improvements.
3. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:

1. Division 31 Section "EARTH MOVING" for soil materials, excavating, backfilling, and site grading.

1.4 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.5 MATERIAL OWNERSHIP

A. Except for stripped topsoil and excess satisfactory soil, or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.6 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without coordination with the Department and authorities having jurisdiction. Coordinate any adjusted traffic alterations with the Department at least 3 days prior to the completion of the work.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to the drawings.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

A. Do not excavate within tree protection zones, unless otherwise indicated.

B. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

C. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by the Department.

1. Replace trees that cannot be repaired and restored to full-growth status, as determined by the Department.

3.4 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify the Department not less than three days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without the Department's written permission.

3.5 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove concrete structures, slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.6 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property, unless indicated otherwise within the contract documents.

1. Suitable fill can be hauled and dumped within the limits of the owners property, within 3 miles of the project site.

2. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION

SECTION 312000

EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The specifications sections “General Conditions of the Construction Contract”, and “Special Conditions”, and “Division 1 - General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 SUMMARY

A. This Section includes the following:
   1. Preparing sub-grades for walks, pavements, lawns and grasses.

B. Related Sections include the following:
   1. Division 32 Section "Turf and Grasses" for finish grading, including preparing and placing topsoil and planting soil for lawns.

1.3 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the sub-base course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated sub-grade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above sub-grade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below sub-grade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
   2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

3. Unauthorized Excavation: Excavation below sub-grade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, un-stratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650-lbf; measured according to SAE J-1179.
2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp flywheel power and developing a minimum of 48,510-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

I. Sub-base Course: Course placed between the sub-grade and base course for hot-mix asphalt pavement, or course placed between the sub-grade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Sub-grade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below sub-base, drainage fill, or topsoil materials.

1.4 SUBMITTALS

A. Make submissions in accordance with 'SCHEDULE OF MATERIAL SUBMITTALS', attached at end of the Specifications.

B. No deviations, substitutions or changes of materials, to be incorporated into this project, shall be made after approval by the Department, except for written direction by and the approval of the manufacturer of a specific item and re-approval by the Department.

C. The Department retains the right to require additional items not specifically denoted to be submitted for approval and/or additional clarification.

1.5 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: The contractor will hire an independent testing agency qualified according to ASTM E 329 to conduct soil materials testing, compaction testing and rock-definition testing, as documented according to ASTM D 3740 and ASTM E 548. All materials under this Section shall be factory certified, first run material, seconds will not be permitted.

B. Non-Compliant Materials - Any material found not to be in compliance with the requirements of this Section, through testing and/or other means, whether installed individually and/or as a

part of a system or not, shall be immediately removed from the job site and replaced with compliant materials at no additional cost to the Contract.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
   1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
   2. Laboratory compaction curve according to ASTM D 698 for each on-site and borrow soil material proposed for fill and backfill.
   3. Compaction Density Test Reports according to ASTM D 2922 – Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

D. Aggregate Material Tests: Conduct aggregate material quality tests in accordance with the following:
   1. PDT Section 703.1, Fine Aggregate
   2. PDT Section 703.2, Coarse Aggregate
   3. PDT Section 703.3 Select Granular Material (2RC)

1.6 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
   1. Notify Department not less than three days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Department's written permission.
   3. Contact utility-locator service for area where Project is located before excavating.

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

PART 2 - PRODUCTS
DISCLAIMER:

2.1 Items specified by specific name of a manufacturer is only to provide a guide to type, performance quality, characteristics, etc. Equal products by manufacturers not specified will be considered for inclusion into this project provided that they are submitted with sufficient supporting data/ information on which to base a decision for approval. In certain cases, which will be so noted, specific items **must** be used in order to be compatible with existing systems.

2.2 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM AASHTO M 145 Soil Classification Groups A-1, A-2-4, A-2-5, and A-3, or a combination of

these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Sub-base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

I. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
   1. Red: Electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of sub-grade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.

D. Provide protective insulating materials to protect sub-grades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared sub-grades, and from flooding Project site and surrounding area.

B. Protect sub-grades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
   2. Install a dewatering system to keep sub-grades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Explosives may not be used for any part of this project.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to sub-grade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

B. Classified Excavation: Excavate to sub-grade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Department. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract time may be authorized for rock excavation.
   1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
      a. Intermittent ram hammering; or ripping of material not classified as rock excavation is earth excavation.
      b. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
   1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
   2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and sub-grades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit, unless otherwise indicated.
   1. Clearance: As indicated on contract drawings or as recommended by the manufacturer.

C. Trench Bottoms: Excavate trenches 6 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.

3.8 SUBGRADE INSPECTION

A. Notify Department when excavations have reached required sub-grade.

B. If the contractor encounters unforeseen sub-grade conditions that are considered unsatisfactory for construction or that do not meet compaction requirements, they will notify the department prior to any further excavation or site construction. If the Department determines that unforeseen unsatisfactory sub-grade is present, they will determine the additional work to be completed and submit a change order request through the contracting officer.

C. Proof-roll sub-grade below the pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated sub-grades.
   1. Completely proof-roll sub-grade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph .
   2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons .

3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

E. Reconstruct sub-grades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Department, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi , may be used when approved by Department.
   1. Fill unauthorized excavations under other construction or utility pipe as directed by Department.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 UTILITY TRENCH BACKFILL

A. Place backfill on sub-grades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

D. Place and compact final backfill of satisfactory soil to final sub-grade elevation.

E. Install warning tape directly above utilities, 12 inches (300 mm) above top of pipe, except 6 inches (150 mm) below sub-grade under pavements and slabs.

F. Utility Trenches that are located at or near finished pavement or structures will be tested for compaction, according to ASTM D 2922. Backfill will not exceed 6” lifts at these locations.

3.12 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Surveying locations of underground utilities for Record Documents.
   2. Removing trash and debris.

3. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
4. Testing and inspecting underground utilities.
5. Removing concrete formwork.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on sub-grades free of mud, frost, snow, or ice.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
1. Under walks and pavements, use satisfactory soil material.

C. Place soil fill on sub-grades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate sub-grade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
1. Under structures, building slabs, steps, and pavements, scarify and re-compact top 12 inches of existing sub-grade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and re-compact top 6 inches below sub-grade and compact each layer of backfill or fill soil material at 92 percent.
3. Under lawn or unpaved areas, scarify and re-compact top 6 inches below sub-grade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent. Utility trenches within a pavement area shall be compacted according to #1 above.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Grading inside Building Lines: Finish sub-grade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

C. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish sub-grades to required elevations within the following tolerances:
   1. Lawn or Unpaved Areas: Plus or minus 1/2 inch.
   2. Walks: Plus or minus 1/2 inch .
   3. Pavements: Plus or minus 1/4 inch.

3.17 SUBBASE AND BASE COURSES

A. Place sub-base and base course on sub-grades free of mud, frost, snow, or ice.

B. On prepared sub-grade, place sub-base and base course under pavements and walks as follows:
   1. Install separation geotextile on prepared sub-grade according to manufacturer's written instructions, overlapping sides and ends.
   2. Place base course material over sub-base course under hot-mix asphalt pavement.
   3. Shape sub-base and base course to required crown elevations and cross-slope grades.
   4. Place sub-base and base course 6 inches or less in compacted thickness in a single layer.
   5. Place sub-base and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   6. Compact sub-base and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.18 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test sub-grades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Sub-grade: At footing sub-grades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing sub-grades may be based on a visual comparison of sub-grade with tested sub-grade when approved by the Department.

D. Testing agency will test compaction of soils in place according to ASTM D 2922 as applicable. Tests will be performed at the following locations and frequencies:
   1. Paved and Building Slab Areas: At sub-grade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab, but in no case fewer than 3 tests.
   2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet (30 m) or less of wall length, but no fewer than 2 tests.
   3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet (46 m) or less of trench length, but no fewer than 2 tests.

E. When testing agency reports that sub-grades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.

F. The contractor will provide the Department with copies of all test reports prior to final backfill and certification of calibration of nuclear density gauge.

3.19 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and re-compact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Department's property.
   1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Department's property.
   2. The Department will retain all satisfactory soils originated from Ft. Indiantown Gap.

END OF SECTION

SECTION 312319

DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes construction dewatering.

B. Related Sections include the following:

1. Division 31 Section "Earthwork" for excavating, backfilling, site grading and for site utilities.

1.3 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.

1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, so that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
4. Remove dewatering system if no longer needed.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

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

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches (600 mm) below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 312319

SECTION 321216

ASPHALT PAVING

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.3 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Pavement-marking paint.

B. Related Sections include the following:

1. Division 31 Section "Earthwork" for aggregate sub-base and base courses and for aggregate pavement shoulders.

1.4 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

B. DOT: Department of Transportation.

1.5 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt paving according to materials, workmanship, and other applicable requirements of standard specifications of state or local DOT.

1. Standard Specification: PENNDOT SPECIFICATION 408
2. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 SUBMITTALS

A. Make submissions in accordance with 'SCHEDULE OF MATERIAL SUBMITTALS', attached at end of the Specifications.

B. No deviations, substitutions or changes of materials, to be incorporated into this project, shall be made after approval by the Department, except for written direction by and the approval of the manufacturer of a specific item and re-approval by the Department.

C. The Department retains the right to require additional items not specifically denoted to be submitted for approval and/or additional clarification.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: PENNDOT APPROVED.

B. Testing Agency Qualifications: All tests and reports shall be in accordance with PENNDOT Section 408 Specification.

C. Regulatory Requirements: Comply with PENNDOT 408 for asphalt paving work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Prime and Tack Coats: Minimum surface temperature of 60 deg F.
2. Slurry Coat: Comply with weather limitations of ASTM D 3910.
3. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 40 deg F at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for oil-based materials, 50 deg F for water-based materials, and not exceeding 95 deg F .

PART 2 - PRODUCTS

2.1 DISCLAIMER: Items specified by specific name of a manufacturer is only to provide a guide to type, performance quality, characteristics, etc. Equal products by manufacturers not specified will be considered for inclusion into this project provided that they are submitted with sufficient supporting data/ information on which to base a decision for approval. In certain cases, which will be so noted, specific items **must** be used in order to be compatible with existing systems.

2.2 ASPHALT MATERIALS

A. Prime Coat: Asphalt emulsion prime complying with PENNDOT 408, Section 461

1. Class AE-P.

B. Tack Coat: PENNDOT 408, Section 460 - TACK.

1. Temperature: Min 90 deg F – Max 150 deg F.

C. Water: Potable.

D. Undersealing Asphalt: ASTM D 3141, pumping consistency.

2.3 AUXILIARY MATERIALS

E. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

F. Sand: ASTM D 1073, Grade Nos. 2 or 3.

G. Paving Geotextile: PENNDOT Pub. 408, Section 467, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications. Thickness = 0.135” (min), weight = 0.8 lbs/sf (min.), Tensile Strength = 2000 psi (min), elongation = 20% min.

H. Joint Sealant: Joint Sealant: ASTM D 6690 or AASHTO M 324, Type III, as directed, hot-applied, single-component, polymer-modified bituminous sealant.

1. Recommended: Seal Master - Crack Master 3405 or Approved Equal

I. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with FS TT-P-115, Type I or AASHTO M 249, Type N.

1. Color:
   a. White. (Standard Parking Spaces and Traffic Indicators)
   b. Blue: (All Handicap Accessible symbols and signage)
   c. Yellow: (Taxiway Lines & Markings)

J. Glass Beads: AASHTO M247, Type 1

2.4 MIXES

K. PENNDOT Superpave: Hot Mixed Asphalt (HMA) - Virgin Mix, Mix Containing 5% to 15% RAP. Furnish material conforming to the requirements of Standard Specifications for Performance-Graded Asphalt Binder using Multiple Stress Creep Recovery (MSCR) Test, AASHTO M 332, except as revised in Bulletin 25. Obtain material from a source listed in Bulletin 15 for the specified grade.

1. Wearing Course: PENNDOT 9.5 mm HMA – PG64S-22
2. Binder Course: PENNDOT 19 mm HMA – PG64S-22
3. Base Course: PENNDOT 25mm HMA – PG64S-22

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that sub-grade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll sub-base using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared sub-grade is ready to receive paving.

1. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.

B. Tack Coat: Apply uniformly to surfaces of existing pavement and sub-base at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 HOT MIXED ASPHALT PLACING

A. Machine place HMA asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place HMA asphalt base course in number of lifts and thicknesses indicated.
2. Place HMA asphalt surface course in single lift.
3. Spread mix at minimum temperature of 275 deg F or as specified by PENNDOT pavement mix design.
4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of WMA asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches .
4. Construct transverse joints as described in PENNDOT 409.3(k).
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct lay-down and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to AASHTO T 245, but not less than 94 percent nor greater than 100 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch .
2. Surface Course: Plus 1/4 inch , no minus.

B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch .
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch .

3.7 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with the Department.

B. Allow paving to age for 15 days before starting pavement marking, unless otherwise specified by the manufacturer.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports.

1. Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

3.9 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow excavated materials to accumulate on-site.

END OF SECTION

SECTION 323113

CHAIN-LINK FENCES AND GATES

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions

1.3 SUMMARY

A. Section Includes:

1. Chain-Link Fences.
2. Cantilever Gates.
3. Swing Gates.
4. Cast-in-Place Concrete Post Footings.

B. Related Sections:

1. Division 31 Section "Earth Moving” for site excavation, fill, and backfill where chain-link fences and gates are located.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Chain-link fence and gate framework shall match the existing military equipment parking area fencing and withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to:

1. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified and on the following:

a. Wind Loads: 80 mph.
b. Exposure Category: B.
c. Fence Fabric Height: 7 feet.
d. Max. Post Spacing: 10 feet.
e. Material Group: IA, ASTM F 1043, Schedule 40 steel pipe.

1.5 SUBMITTALS

A. Make submissions in accordance with 'SCHEDULE OF MATERIAL SUBMITTALS' attached at end of the Specifications.

B. No deviations, substitutions or changes of materials, to be incorporated into this project shall be made after approval by the Department, except for written direction by and the approval of the manufacturer of a specific item and re-approval by the Department.

C. The Department retains the right to require additional items not specifically denoted to be submitted for approval and/or additional clarification.

D. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.

E. Shop Drawings: Include plans, elevations, sections, details, operational clearances, and attachments to other work. Show locations of fences, gates, posts, rails, tension wires, and operational clearances, details of extended posts, post anchorage, bracing, extension arms, gate swing, or other operational hardware and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components.

F. Product Certificates: For each type of chain-link fence and gate from manufacturer.

G. Product Test Reports: For framing strength according to ASTM F 1043.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed chain-link fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for chain-link fences and gates shown on the Contract Drawings in relation to existing structures. Verify dimensions by field measurements.

PART 2 - PRODUCTS

DISCLAIMER:

2.1 Items specified by specific name of a manufacturer are only to provide a guide to type, performance quality, characteristics, etc. Equal products by manufacturers not specified will be considered for inclusion into this project provided they are submitted with sufficient supporting data/ information on which to base a decision for approval. In certain cases, which will be so noted, specific items must be used to be compatible with existing systems.

2.2 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: Seven (7) feet, with mill finished, and 9 gauge wire.

   a. Aluminum-Coated Fabric: ASTM A 491, Type I, 0.35 oz./sq. ft. (107 g/sq. m)]

2. Mesh Size: 2 inches.

3. Selvage: Twisted at both selvages.

2.3 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:

1. Fence Height: 84 inches.
2. Light Industrial Strength: Material Group IC-L, round steel pipe, electric-resistance-welded pipe.
   a. Line Post: 3 inches outside diameter (O.D.).
   b. End, Corner and Pull Post: 3 inches outside diameter (O.D.).

3. Horizontal Framework Members: Top rails complying with ASTM F 1043.

   a. Top Rail: N/A.

4. Brace Rails: Comply with ASTM F 1043.
5. Metallic Coating for Steel Framing:
   a. Type C, Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. coating.

2.4 TENSION WIRE

A. General: Provide horizontal tension wire along bottom and top of fence fabric.

B. Type I, aluminum coated (aluminized).: 0.192-inch diameter tension wire, mill finished, complying with ASTM B 211, Alloy 6061-T94 with 50,000-psi minimum tensile strength.

2.5 HORIZONTAL-SLIDE GATES

A. General: Comply with ASTM F 1184 for gate posts and single sliding gate types.

1. Classification: Type II Cantilever Slide, Class 1 with external roller assemblies.

   a. Gate Frame Width and Height: More than 48 inches wide by 96 inches height.

B. Pipe and Tubing:

1. Zinc-Coated Steel: Protective coating and finish to match fence framing
2. Gate Posts: Comply with ASTM F 1184. Provide round tubular steel.
3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate framed as required to attach barbed wire assemblies.

E. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.

F. Hardware:

1. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
2. Lock: Manufacturer's standard.
3. Hangers, roller assemblies, and stops fabricated from Grade 319 aluminum-alloy casting with stainless-steel fasteners.

2.6 SWING GATES

A. General: Comply with ASTM F 900 for gate posts and single swing gate types.

1. Gate Leaf Width: 10 feet.
2. Gate Fabric Height: 7 Feet.

B. Pipe and Tubing:

1. Zinc-Coated Steel: Protective coating and finish to match fence framing.
2. Gate Posts: Round tubular steel.
3. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: Welded.

D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches to attach barbed wire assemblies.

E. Hardware:

1. Hinges: 360-degree inward and outward swing.
2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
3. Closer: Manufacturer's standard.

2.7 FITTINGS

A. General: Comply with ASTM F 626.

B. Post Caps: Provide for each post.
   1. Caps must be permanently affixed to post by weld, peening or other approved means.

C. Rail and Brace Ends: For each gate, corner, pull, and end post.

D. Rail Fittings: Provide the following:
   1. Rail Clamps: Line and corner boulevard clamps for connecting intermediate rails in the fence line-to-line posts.

E. Tension and Brace Bands: Aluminum Alloy 6063.

F. Tension Bars: Aluminum, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.

G. Truss Rod Assemblies: Mill-finished aluminum rod and turnbuckle or other means of adjustment.

H. Barbed Wire Arms: Aluminum with clips, slots, or other means for attaching strands of barbed wire and means for attaching to posts for each post unless otherwise indicated, and as follows:

   1. Provide line posts with arms that accommodate top rail or tension wire.
   2. Provide corner arms at fence corner posts, unless extended posts are indicated.
   3. Type I, single slanted arm.

I. Tie Wires, Clips, and Fasteners: According to ASTM F 626.

   1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
      a. Aluminum: ASTM B 211; Alloy 1350-H19; 0.148-inch diameter, mill-finished wire.

J. Finish:

   1. Aluminum: Mill finish.

2.8 BARBED WIRE (N.I.C.)

A. Steel Barbed Wire: Comply with ASTM A 121, for two-strand barbed wire, 0.099-inch diameter line wire with 0.080-inch diameter, four-point round barbs spaced not more than 5 inches o.c.

   1. Aluminum Coating: Type A.

2.9 CAST-IN-PLACE CONCRETE POST FOOTINGS

A. Class A concrete conforming to PennDOT Pub. 408 and placed as indicated on the Contract Drawings.

2.9 GROUT AND ANCHORING CEMENT

A. Non-shrink, Nonmetallic Grout: Premixed, factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, non-shrink, non-staining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

2.10 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper.
2. Material on or below Finished Grade: Copper.
3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.

B. Connectors and Grounding Rods: Comply with UL 467.

4. Connectors for Below-Grade Use: Exothermic welded type.
5. Grounding Rods: Copper-clad steel, 3/4 by 120 inches .

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with the Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by the Department.

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

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 INSTALLATION, GENERAL

A. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

3.4 CHAIN-LINK FENCE INSTALLATION

A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

    a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.

C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

D. Line Posts: Space line posts uniformly at 10 feet o.c.

E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

1. Locate horizontal braces at mid-height of fabric 72 inches or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.

F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:

1. Extended along the bottom of fence fabric. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

H. Intermediate and Bottom Rails: Install and secure to posts with fittings.

I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie

to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.

K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Wire should be wrapped 360 degrees around line post or brace, securing fabric to post, with twisted connection placed on the secure side of the fence. Bend ends of wire to minimize hazard to individuals and clothing.

1. Maximum Spacing: Tie fabric to line posts at 15 inches o.c. and to braces at 24 inches o.c.

L. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.

M. Barbed Wire: Install barbed wire uniformly spaced angled toward security side of fence. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms. (N.I.C.)

3.5 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.6 GROUNDING AND BONDING

A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:

1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.

a. Gates and Other Fence Openings: Ground fence on each side of opening.

1) Bond metal gates to gate posts.
2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.

D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:

1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.

E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

F. Connections: Make connections to minimize possibility of galvanic action or electrolysis. 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 in 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.

G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

3.7 FIELD QUALITY CONTROL

A. Grounding-Resistance Testing: The contractor will hire a qualified testing agency to perform tests and inspections.

1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware and other moving parts.

END OF SECTION

SECTION 329200

TURFS and GRASSES

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

1.3 SUMMARY

A. This Section includes the following:

1. Seeding.

B. Related Sections include the following:

1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.

1.4 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

D. Sub-grade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.5 SUBMITTALS

A. Make submissions in accordance with 'SCHEDULE OF MATERIAL SUBMITTALS' attached at end of the Specifications.

B. No deviations, substitutions or changes of materials, to be incorporated into this project, shall be made after approval by the Government, except for written direction by and the approval of the manufacturer of a specific item and re-approval by the Government.

C. The Government retains the right to require additional items not specifically denoted to be submitted for approval and/or additional clarification.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Government of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

1.8 SCHEDULING

A. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.9 LAWN MAINTENANCE

A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Seeded Lawns: 60 days from date of Substantial Completion.

a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.

B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches (100 mm).

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water lawn at a minimum rate of 1 inch (25 mm) per week.

D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow grass 2 to 3 inches (38 to 50 mm) high.

E. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) to lawn area.

PART 2 - PRODUCTS

2.1 DISCLAIMER: Items specified by specific name of a manufacturer is to only provide a standard for characteristics, type, quality, performance, etc. Equal products by manufacturers not specified will be considered for inclusion into this project provided that they are submitted with sufficient supporting data/ information on which to base a decision for approval. In certain cases, which will be so noted, specific items **must** be used in order to be compatible with existing systems.

2.2 Manufacturer's

A. Seedway, Inc.

B. Or Approved Equal

2.3 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

1. Seed Mix: PENNDOT 408, Section 804 – Formula L

2.4 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 2 percent organic material content; free of stones 1 inch (25 mm) or larger in any dimension and other extraneous materials harmful to plant growth.

1. Topsoil Source: Off-site Topsoil will be required. Verify suitability of topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land**,** bogs or marshes.

2.5 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:

1. Class: Class T, with a minimum 99 percent passing through No. 8 (2.36-mm) sieve and a minimum 75 percent passing through No. 60 (0.25-mm) sieve.

2.6 FERTILIZER

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.7 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

A. Limit lawn subgrade preparation to areas to be planted.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Government's property.

1. Apply fertilizer directly to subgrade before loosening.
2. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.

    a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
    b. Mix lime with dry soil before mixing fertilizer.

3. Spread planting soil mix to a depth of 6 inches (150 mm) but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

    a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 4 inches (100 mm) of subgrade. Spread remainder of planting soil mix.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

D. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.

B. Sow seed at the rate of 3 to 4 lb/1000 sq. ft. (1.4 to 1.8 kg/92.9 sq. m).

C. Rake seed lightly into top 1/8 inch (3 mm) of topsoil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 4:1 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with slopes not exceeding 6:1 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre (42 kg/92.9 sq. m) to form a continuous blanket 1-1/2 inches (38 mm) in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.

3.5 SATISFACTORY LAWNS

A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).

B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.6 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

C. Remove erosion-control measures after grass establishment period.

END OF SECTION