

TABLE OF CONTENTS OF SPECIAL PROVISIONS

Note: This Table of Contents has been prepared for the convenience of those using this contract with the sole express purpose of locating quickly the information contained herein; and no claims shall arise due to omissions, additions, deletions, etc., as this Table of Contents shall not be considered part of the contract.

Table of Contents

TABLE OF CONTENTS OF SPECIAL PROVISIONS.....	1
CONTRACT TIME AND LIQUIDATED DAMAGES.....	3
NOTICE TO CONTRACTOR - PRE-BID QUESTIONS AND ANSWERS.....	4
NOTICE TO CONTRACTOR - PRE-BID SITE VISIT.....	5
NOTICE TO CONTRACTOR - PROJECT DESCRIPTION.....	6
NOTICE TO CONTRACTOR - PROJECT SUPERINTENDENT	8
NOTICE TO CONTRACTOR - FIRE WATCH.....	9
NOTICE TO CONTRACTOR - SUBMITTALS.....	10
NOTICE TO CONTRACTOR - EARLY SUBMITTALS.....	13
NOTICE TO CONTRACTOR - SOLE SOURCE PRODUCTS.....	14
NOTICE TO CONTRACTOR - POTENTIAL FOR ASBESTOS	16
CONTAINING MATERIALS	16
NOTICE TO CONTRACTOR - PRE-INSTALLATION MEETINGS	17
NOTICE TO CONTRACTOR - CAD FILES.....	18
NOTICE TO CONTRACTOR - 30-DAY SYSTEM OPERATIONAL TESTS.....	19
NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS	20
NOTICE TO CONTRACTOR - HAZARDOUS MATERIALS	23
INVESTIGATIONS	23
NOTICE TO CONTRACTOR - FEDERAL WAGE DETERMINATIONS (Davis Bacon Act)	24
SECTION 1.20 - GENERAL CLAUSES FOR FACILITIES	25
CONSTRUCTION	25
ON-THE-JOB TRAINING (OJT) WORKFORCE DEVELOPMENT PILOT	40
D.B.E. SUBCONTRACTORS AND MATERIAL SUPPLIERS OR.....	44
MANUFACTURERS.....	44
ITEM #0000191A - NON-DESTRUCTIVE UTILITY INVESTIGATION	56
(ESTIMATED COST)	56
ITEM #0101019A - INDOOR AIR QUALITY MANAGEMENT PLAN	58
ITEM #0101143A - HANDLING AND DISPOSAL OF REGULATED ITEMS	63
ITEM #0177150A - GENERAL BUILDING RENOVATION	72
ITEM #0969742A - PHOTGRAPHIC DOCUMENTATION.....	73
ITEM #1008700A - 4" RIGID METAL MULTI DUCT CONDUIT - SURFACE	76
ITEM #1108504A - EQUIPMENT RACK.....	82
ITEM #1108539A - MODIFY EXISTING OPERATIONS CENTER.....	92
CONTROL SYSTEM.....	92
ITEM #1108745A - VIDEO AND GRAPHICS WALL EQUIPMENT	111
INDEX OF CSI-FORMATTED SPECIFICATIONS.....	151
PERMITS AND/OR REQUIRED PROVISIONS	1160

MARCH 7, 2018
FEDERAL AID PROJECT NO. 1093(119)
STATE PROJECT NO. 93-210

DEPARTMENT OF TRANSPORTATION
HIGHWAY OPERATIONS CENTER
EXPANSION AND RENOVATION

Town of Newington
Federal Aid Project No. 1093(119)

The State of Connecticut, Department of Transportation, Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, Form 817, 2016, as revised by the Supplemental Specifications dated July 2017 (otherwise referred to collectively as "ConnDOT Form 817") is hereby made part of this contract, as modified by the Special Provisions contained herein. Form 817 is available at the following DOT website link <http://www.ct.gov/dot/cwp/view.asp?a=3609&q=430362>. The current edition of the State of Connecticut Department of Transportation's "Construction Contract Bidding and Award Manual" ("Manual"), is hereby made part of this contract. If the provisions of this Manual conflict with provisions of other Department documents (not including statutes or regulations), the provisions of the Manual will govern. The Manual is available at the following DOT website link <http://www.ct.gov/dot/cwp/view.asp?a=2288&q=259258>. The Special Provisions relate in particular to the DEPARTMENT OF TRANSPORTATION HIGHWAY OPERATIONS CENTER EXPANSION AND RENOVATION in the Town of Newington.

CONTRACT TIME AND LIQUIDATED DAMAGES

Six hundred forty-four (644) calendar days will be allowed for completion of the work on this Contract and the liquidated damages charge to apply will be Three Thousand Seven Hundred Dollars (\$3700.00) per calendar day.

NOTICE TO CONTRACTOR - PRE-BID QUESTIONS AND ANSWERS

Questions pertaining to DOT advertised construction projects must be presented through the CTDOT Pre-Bid Q and A Website. The Department cannot guarantee that all questions will be answered prior to the bid date. **PLEASE NOTE - at 9:00 am Monday (i.e. typical Wednesday Bid Opening) the project(s) being bid will be closed for questions, at which time questions can no longer be submitted through the Q and A Website.**

Answers may be provided by the Department up to 12:00 noon, the day before the bid. At this time, the Q and A for those projects will be considered final, unless otherwise stated and/or the bid is postponed to a future date and time to allow for further questions and answers to be posted.

If a question needs to be asked the day before the bid date, please contact the Contracts Unit staff and email your question to dotcontracts@ct.gov immediately.

Contractors must identify their company name, contact person, contact email address and phone number when asking a question. The email address and phone number will not be made public.

The questions and answers (if any) located on the Q and A Website are hereby made part of the bid/contract solicitation documents (located on the State Contracting Portal), and resulting contract for the subject project(s). It is the bidder's responsibility to monitor, review, and become familiar with the questions and answers, as with all bid requirements and contract documents, prior to bidding. By signing the bid proposal and resulting contract, the bidder acknowledges receipt of, and agrees to the incorporation of the final list of Q and A, into the contract document.

Contractors will not be permitted to file a future claim based on lack of receipt, or knowledge of the questions and answers associated with a project. All bidding requirements and project information, including but not limited to contract plans, specifications, addenda, Q and A, Notice to Contractors, etc., are made public on the State Contracting Portal and/or the CTDOT website.

NOTICE TO CONTRACTOR - PRE-BID SITE VISIT

A Pre-Bid Site Visit will be held on Wednesday May 2, 2018 at 10 a.m. Attendees should plan on arrival at the Headquarters Facility prior to 10 a.m. so they can sign in with Security to be issued a temporary ID badge.

Work for this Project involves areas that are part of the Headquarters Facility and access to the area is restricted. Therefore, all bidders are strongly encouraged to attend this Pre-Bid Site Visit. There will be no other opportunity afforded to bidders to inspect the Project site. The Pre-Bid Site Visit will consist of a walking tour of the areas where work will be performed.

Those planning to attend must contact Mr. Philip J. Melchionne, Contract Section, prior to April 27, 2018, at **DOTContracts@ct.gov** for confirmation. You must provide your name, name of firm, phone number, and number of attendees.

Bidders are advised that no questions will be entertained at the site visit. For all questions you must follow the procedure explained in **“NOTICE TO CONTRACTOR – PRE-BID QUESTIONS AND ANSWERS.”** All questions must be submitted no later than 3:30 P.M., May 4, 2018.

NOTICE TO CONTRACTOR - PROJECT DESCRIPTION

The Project consists of renovations to support a new Highway Operations Center within the Department of Transportation Headquarters located in Newington, Connecticut as shown and described in the Contract.

Building work consists of selective demolition of existing ground floor spaces to construct new:

1. Highway Operations Center (HOC), Video & Data Transfer Room (VDTR), Storm Center, Traffic Incident Management (TIM) Room, Engineering Offices, private offices, along with a kitchen, toilet, and storage rooms.
2. Nurse, Gift Shop, Library, IT Engineering Applications, OIS Room, Conference Rooms, private offices, and storage rooms.

The building work includes concrete; structural steel, metal fabrications, and railings; rough carpentry and fiberglass reinforced plastic products; insulation, fireproofing, firestopping, and sealants; doors and frames, hardware, glazing, and louvers and vents; gypsum partitions, tiling, acoustical tile ceilings, flooring, carpeting, and interior painting; visual display surfaces, signage, wood paneling, toilet and bath accessories, and fire extinguishers and cabinets; appliances; louver blinds, casework, countertops, and entrance floor mats; sprinkler and standpipe systems, clean agent fire suppression systems; plumbing; heating-ventilating-air conditioning; electrical and lighting systems; communications systems; and electronic safety and security systems.

The building work also includes equipping the HOC with all of the computer, network, communications, and video display equipment required to support the duties of the operations center staff, engineering staff, TIM activities, and other facility functions.

The HOC is the headend of the Advanced Traffic Management System (ATMS) that monitors and manages traffic on major highways throughout the state of Connecticut. The principal objective of the HOC is to quickly identify problems on the road and coordinate appropriate responses to mitigate those problems. The HOC has a large video wall to display feeds from over 300 CCTV cameras installed on the highways around the state. There are a number of workstations for the HOC staff equipped with computers, telephone and radio systems that provide the ability to control electronic highway signs, communicate with other DOT personnel and emergency services, and manage other DOT activities on the highway.

Immediately adjacent to the HOC is the VDTR that houses the communications, networking and computing equipment used by the HOC. The computer system runs the ATMS software. The ATMS system transmits and receives data to and from field equipment using fiber optic communications equipment.

All video from CCTV cameras around the state is managed by equipment installed in equipment racks located in the VDTR. Video is transmitted from roadside CCTV cameras over fiber optic cables that enter the building in the Communications Room and from there to the VDTR. Fiber-

optic transceivers convert the optical video signals to baseband video and connect to a video matrix switch that, in turn, is connected to the video management system for display of the video on the various display systems in the HOC.

The HOC also houses a TIM Room. The TIM Room will be used for a number of functions including multi-agency coordination during major events, after-action meetings and "table-top" emergency response exercises, and other large meetings. The TIM Room will be equipped with a video display system that will allow video from any ConnDOT source to be displayed, in addition to providing the ability for visiting personnel to connect to the display system. The TIM Room will also be equipped with a speaker's podium and controller for the display, audio and lighting systems.

The site work includes the removal and replacement of concrete sidewalk, fencing and landscape screening for mechanical equipment, and miscellaneous related work.

Environmental work associated with this facility includes the removal and disposal of regulated items removed during the facility renovation, such as lights, ballasts, thermostats, and other similar items as indicated in the NOTICE TO CONTRACTOR – HAZARDOUS MATERIALS INVESTIGATION.

NOTICE TO CONTRACTOR - PROJECT SUPERINTENDENT

The Contractor is directed to Form 817 Article 1.20-1.05.05 for requirements for the Project Superintendent. The Contractor shall bid the project accordingly.

NOTICE TO CONTRACTOR - FIRE WATCH

The Owner's Security Vendor shall provide the services of personnel assigned the dedicated function of a 24-7-365 "fire watch" throughout all areas of the building where the sprinkler system is out of service. This "fire watch" will permit Department personnel and the public to occupy the building.

The Contractor shall request the need for a "fire watch" in each Biweekly Schedule.

The Engineer will schedule a 2 hour long Fire Watch Training Program prior to the Contractor's performance of any physical work on the project. At a minimum the Contractor's Project Superintendent shall attend. Topics of discussion shall include, but are not limited to duties and expectations, log contents, fire and other emergency reporting procedures, radio procedures, and a walking tour of the project.

The Contractor shall bid the project accordingly.

NOTICE TO CONTRACTOR - SUBMITTALS

Unless otherwise noted, the Designer will be the “submittal reviewer.” Product Samples for review for conformance with the Contract shall be transmitted by letter and hand delivered or sent by mail directly to the “submittal reviewer.” Mailing addresses will be provided at the Pre-Construction Meeting.

Engineer: The Engineer will be the “submittal reviewer” for the following materials:

1. Demolition Plan
2. Disposal Plan
3. Welding (Welder) Certificates
4. Certified Test Reports, Material Certificates, etc. from Form 817 Standard Items (non “A” Items from Bid List)
5. “Non-A” items, including those items in CSI-Formatted Specifications
6. All test reports identified in CSI-formatted Specification except for Testing, Adjusting, and Balancing Reports

Environmental Compliance: Environmental Compliance is the “submittal reviewer” for review of work identified in the following special provisions:

1. Item No. 0101114A – Indoor Air Quality Management Plan
2. Item No. 0101143A – Handling and Disposal of Regulated Items

Owner Occupant: The Owner Occupant is the “submittal reviewer” for review of work are identified in the following CSI Sections and special provisions:

1. Item No. 1008700A, “4” Rigid Metal Multi Duct Conduit – Surface”
2. Item No. 1108745A, “Video and Graphics Wall Equipment”
3. Item No. 1108504A, “Equipment Rack”
4. CSI Division 27 Section 275119, “Sound Masking Systems”
5. CSI Division 27 Section 276270, “Central Radio System”

The Owner Occupant is identified as an outside agency as a secondary “submittal reviewer” for review of work are identified in the following CSI Sections and special provisions:

1. Item No. 1108539A, “Modify Existing Operations Center Control System”
2. CSI Division 08 Section 083213, “Sliding Aluminum-Framed Glass Doors”
3. CSI Division 09 Section 095113, “Acoustical Tile Ceilings”
4. CSI Division 09 Section 093000, “Tiling”
5. CSI Division 09 Section 096813, “Tile Carpeting”
6. CSI Division 09 Section 096900, “Access Flooring”
7. CSI Division 11 Section 113100, “Appliances”
8. CSI Division 12 Section 123213, “Manufactured Wood-Veneer-Faced Casework”

9. CSI Division 12 Section 123600, "Countertops"
10. CSI Division 21 Section 212200, "Clean-Agent Fire-Extinguishing Systems"
11. CSI Division 23 Section 238126, "Split-System Air Conditioners"
12. CSI Division 26 Section 260526, "Grounding and Bonding for Electrical Systems"
13. CSI Division 26 Section 260923, "Lighting Control Devices"
14. CSI Division 26 Section 262415, "Static Uninterruptible Power Supply and Wall Maintenance Bypass Switch"
15. CSI Division 26 Section 262416, "Panelboards"
16. CSI Division 26 Section 262727, "Floor Boxes Wiring Device"
17. CSI Division 26 Section 262728, "Track Busway"
19. CSI Division 26 Section 265119, "LED Interior Lighting"
20. CSI Division 27 Section 270526, "Grounding and Bonding"
21. CSI Division 27 Section 271313, "Communications Copper Backbone Cabling"
22. CSI Division 27 Section 271513, "Communications Copper Horizontal Cabling"

The Department will forward the noted submittals to the owner occupant for their review, with owner occupant comments being sent back to the Department's consultant for inclusion in one response to the Contractor. Hence, the Contractor shall allow 28 calendar days for outside agency review of the submittals noted above.

Siemens: Siemens, as the Department's building operator, is identified as an outside agency as a secondary "submittal reviewer" for review of work are identified in the following CSI Sections:

1. CSI Division 23 Section 230900, "Instrumentation and Control for HVAC"
2. CSI Division 23 Section 230994, "Sequence of Operations for HVAC"
3. CSI Division 28 Section 281300, "Access Control"
4. CSI Division 28 Section 283100, "Fire Alarm System"

The Department will forward the noted submittals to the building operator for their review, with building operator comments being sent back to the Department's consultant for inclusion in one response to the Contractor. Hence, the Contractor shall allow 28 calendar days for outside agency review of the submittals noted above.

FM Global: FM Global is identified as an outside agency as a secondary "submittal reviewer" for review of work are identified in the following CSI Sections:

1. Division 21 Section 211200, "Fire-Suppression Standpipes"
2. Division 21 Section 211313, "Wet-Pipe Sprinkler Systems"
3. Division 21 Section 211319, "Preaction Sprinkler Systems"
4. Division 21 Section 212200, "Clean-Agent Fire Extinguishing Systems"

The Department will forward the noted submittals to FM Global for their review, with FM Global comments being sent back to the Department's consultant for inclusion in one response to the Contractor. Hence, the Contractor shall allow 28 calendar days for outside agency review of the submittals noted above.

The Contractor shall send submittals e-mail alerts to the following key personnel:

- Designer (Project Engineer): Mark D. Sawyer; Mark.Sawyer@ct.gov
- Designer (Project Manager): Michael J. Strong; Michael.Strong@ct.gov
- Designer (Consultant Project Manager): Adam Anzzolin;
Adam.Anzzolin@mbakerintl.com
- Construction Project Chief Inspector: Robert F. Flaminio; Robert.Flaminio@ct.gov
- Construction Supervising Engineer: Mark St. Germain; Mark.St.Germain@ct.gov
- Owner: Property and Facilities Representatives
- Owner Occupant: John F. Korte; John.Korte@ct.gov

Add the following for submittals where Environmental Compliance is listed in NOTICE TO CONTRACTOR – SUBMITTALS as the “submittal reviewer:”

- Environmental Designer (Project Engineer): Denise Young; Denise.Young@ct.gov

Other key construction personnel will be identified at the Pre-Construction Meeting.

NOTICE TO CONTRACTOR - EARLY SUBMITTALS

The Contractor is hereby advised that the Department has identified the potential need to order certain materials and equipment, and thereby submit certain submittals for approval early in the construction process to ensure the Project is completed within the allowable Contract Time. Submittals shall be in accordance with Form 817 Article 1.20-1.05.02. The following items have been identified as possibly requiring early ordering thereby requiring early submission of shop drawings and product data, including color selection charts and samples:

All Phase 1 Construction Work including, but not limited to, the following:
Coordination Drawings, Doors and Hardware, Millwork, Sprinkler System work, and Ductwork
Materials that support the construction of the Project such as the those materials identified in the
Limitations of Contractor Operations

The following items have been identified as possibly requiring early submission for purposes of project coordination and project work scheduling:

Baseline Critical Path Schedule
Contractor's Submittal Schedule
Selection of a Project Superintendent
Selection of a Photographer and Videographer

The lists above are not intended to be all-inclusive and do not relieve the Contractor from coordinating the activities of its subcontractors and suppliers. The Contractor will not be permitted to perform any physical work on the Project without the approval of the required submittals. Failure to properly plan for long lead items within the Contract schedule will not be justification for additional construction time.

It is recommended that the Contractor identify early in the construction sequencing process the subcontractors and suppliers associated with long lead-time items and submit the appropriate shop drawings and supporting data, including color selection charts and samples, for review upon Award.

NOTICE TO CONTRACTOR - SOLE SOURCE PRODUCTS

For operational purposes, the Department has determined the need to sole source products specified in the following Contract provisions (including specific CSI-formatted Specifications contained within a particular Special Provision):

1. Baseband Video Coaxial Cables: Item No. 1108539A “Modify Existing Operations Center Control System”
2. Video/Graphics Equipment: Item No.1108745A “Video and Graphics Wall Equipment”
 - a. Video Display Cube
 - b. Video Display Cube Direct Fiber Module
 - c. 55” Flat Panel Display
 - d. Video Display Processor
 - e. Digital KVM Extender
 - f. H.264 Video Encoder
 - g. DVI/HDMI Fiber Optic Extenders
 - h. Universal Remote Control
 - i. EDID Minder
 - j. Over the Air Tuner
 - k. Audiovisual Equipment
 - l. Wireless Collaboration System
 - m. Wireless Microphone System
 - n. Podium
3. Fireproofing: Division 07 Section 078100, “Applied Fireproofing”
4. Door Hardware: Division 08 Section 087100, “Door Hardware.”
 - a. Mechanical Locks and Latches
 - b. Exit Devices and Auxiliary Items
 - c. Lock Cylinders
 - d. Surface Closers
5. Tile Carpeting: Division 09 Section 096813, “Tile Carpeting”
6. Plumbing Fixtures:
 - a. Flushometers: Division 22 Section 224213, “Commercial Water Closets.”
 - b. Lavatory Sink Faucets: Division 22 Section 224216, “Commercial Lavatories and Sinks.”
 - c. Water Filters: Division 22 Section 224713, “Drinking Fountains.”
7. Building Automation Controls: Division 23 Section 230900, “Instrumentation and Controls for HVAC.”
8. Central Radio System: CSI Division 27 Section 276270, “Central Radio System”
 - a. Central Radio System
 - b. Termination Panels and Connections

9. Voice and Data Jacks: Division 27 Section 271513, "Communications Copper Horizontal Cabling."
10. Fire Alarm System: Division 28 Section 283100, "Fire Alarm System."

No "Or Equals" will be permitted. Said products shall be installed only by their factory authorized installer or service representative. The Contractor shall bid the Project accordingly.

NOTICE TO CONTRACTOR - POTENTIAL FOR ASBESTOS CONTAINING MATERIALS

The Contractor shall submit manufacturer certification letters for all materials specified in the following Contract provisions (including CSI-formatted specifications contained within a particular special provision):

1. Division 07 Section 072100, "Thermal Insulation."
2. Division 07 Section 078413, "Penetration Firestopping."
3. Division 07 Section 078100, "Applied Fireproofing."
4. Division 07 Section 079200, "Joint Sealants."
5. Glazing Tapes and Sealants: Division 08 Section 088000, "Glazing."
6. Division 09 Section 092900, "Gypsum Board."
7. Division 09 Section 093000, "Tiling."
8. Division 09 Section 095113, "Acoustical Panel Ceilings."
9. Division 09 Section 096500, "Resilient Flooring."
10. Division 22 Section 220523, "General-Duty Valves for Plumbing Piping."
11. Division 22 Section 220719, "Plumbing Piping Insulation."
12. Division 23 Section 230523, "General-Duty Valves for HVAC Piping."
13. Division 23 Section 230713, "Duct Insulation."
14. Division 23 Section 230719, "HVAC Piping Insulation."
15. Gaskets: Division 23 Section 232113, "Hydronic Piping."
16. Sealants: Division 23 Section 233113, "Metal Ducts."
17. Flexible Connectors and Ducts: Division 23 Section 233300, "Air Duct Accessories."
18. Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables."
19. Division 26 Section 260544, "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

The above list may not be all-inclusive and does not relieve the Contractor from its responsibility to provide manufacturer certification letters that are required under other Contract provisions. Furthermore, the Department may at any time require the Contractor to submit manufacturer certification letters proving that other materials do not contain asbestos.

NOTICE TO CONTRACTOR - PRE-INSTALLATION MEETINGS

The Engineer will conduct a pre-installation meeting at the Project Site before each of the following construction activities:

1. Fire Watch Training Program.
2. Predemolition: Form 817 Article 1.20-1.08.03 – Prosecution of Work, subsection 5 – Selective Demolition.
3. Concrete: CSI Division 03 Section 033000, “Cast-In-Place Concrete.”
4. Sliding Doors: CSI Division 08 Section 083213, “Sliding Aluminum-Framed Glass Doors.”
5. Door Hardware: CSI Division 08 Section 087100, “Door Hardware.”
6. Access Flooring: CSI Division 09 Section 096900, “Access Flooring.”
7. Testing, Adjusting, and Balancing: CSI Division 23 Section 230593, “Testing, Adjusting, and Balancing for HVAC.”

The above list may not be all-inclusive and does not relieve the Contractor from its responsibility to provide pre-installation meetings that are required under other Contract provisions.

NOTICE TO CONTRACTOR - CAD FILES

The Contractor is hereby advised that CAD files will not be provided to construction contract bidders, the Contractor, or any subcontractor. Contract documents, including plans, are provided in Portable Document Format (PDF).

The Department AEC Applications unit has prepared technical reference materials on extending the utility of PDF contract plan sheets. See the Repurposing PDF Contract Plan Sheets web page (<http://www.ct.gov/dot/cwp/view.asp?a=2288&Q=567262&PM=1>).

The Contractor shall bid the Project accordingly.

NOTICE TO CONTRACTOR - 30-DAY SYSTEM OPERATIONAL TESTS

The Contractor is hereby advised of Contract requirements for the performance of 30 Day System Operational Tests for the Video Graphics Wall Equipment and the Central Radio Equipment. Refer to the following special provisions for additional information:

Item # 1108745A, Video and Graphics Wall Equipment
CSI Division 27 Section 276270, "Central Radio System"

The Highway Operations staff will notify the Engineer and the Contractor each time that the 30 Day System Operational Tests begins. The Contract does not require that the (2) 30 Day System Operational Test periods be concurrent, nor does the need to restart one test require the other test to restart.

The Highway Operations staff or the Engineer will notify the Contractor if any problems with the installation are identified, up to and including a test failure. The Contractor shall have the necessary installer respond to the Project site within 3 hours to troubleshoot Monday-Friday from 7 AM to 4:30 PM or within 24 hours for all other times as well as Saturday and Sunday.

NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS

General: The list of special provisions (including CSI-formatted specifications) in the Table below may not be all-inclusive and does not relieve the Contractor from its responsibility to provide spare parts, operation and maintenance manuals, training, and warranties that are required under other Contract provisions.

Spare Parts: The Contractor shall deliver spare parts on products listed in the Table below to the Project Site.

Operation and Maintenance Manuals: Submit in accordance with Form 817 Article 1.20-1.08.14. The Designer and the Owner (Office of Property and Facilities Services) will review the manuals for conformance to the Contract.

Product Maintenance Manual: The Contractor shall provide complete information in the materials and finishes manual on products listed in the Table below.

Equipment and Systems Maintenance Manuals: The Contractor shall provide complete information in the equipment and systems manual on products listed in the Table below.

Training: The Contractor shall provide training on products listed in the Table below.

Warranties: Submit in accordance with Form 817 Article 1.20-1.08.14. The Designer and the Owner will review the warranties for conformance to the Contract.

The Contractor shall provide special warranties on products and installations listed in the Table.

TABLE

Special Provision (including CSI-formatted Specifications)	Warranties	Spare Parts	Training	Operation and Maintenance Manuals
Item #1108745A – Video and Graphics Wall Equipment	X	X	X	X
Item #1108504A – Equipment Rack				X
Item #1108539A – Modify Existing Operations Center Control System	X	X		X
CSI Section 081416, “Flush Wood Doors and Frames”	X			
CSI Section 083213, “Sliding Aluminum-Framed Glass Doors”	X			X
CSI Section 084113, “Aluminum Framed Storefronts and Entrances”	X			
CSI Section 087100, “Door Hardware”	X	X	X	X

Special Provision (including CSI-formatted Specifications)	Warranties	Spare Parts	Training	Operation and Maintenance Manuals
CSI Section 088000, "Glazing"	X			
CSI Section 089000, "Louvers and Vents"	X			
CSI Section 093000, "Tiling"		X		
CSI Section 095113, "Acoustical Panel Ceilings"		X		
CSI Section 096500, "Resilient Flooring"		X		
CSI Section 096813, "Tile Carpeting"	X	X		X
CSI Section 096900, "Access Flooring"		X		
CSI Section 099123, "Painting"		X		
CSI Section 101010, "Visual Display Surfaces"	X			
CSI Section 101400, "Signage"	X			
CSI Section 102600, "Wood Wall Paneling"	X			
CSI Section 102800, "Toilet Accessories"		X		
CSI Section 104400, "Fire-Protection Cabinets and Extinguisher"	X			
CSI Section 113100, "Appliances"	X			X
CSI Section 122113, "Louver Blinds"		X		
CSI Section 123213, "Manufactured Wood-Veneer-Faced Casework"	X	X		
CSI Section 123216, "Plastic Laminate Casework"	X			X
CSI Section 123600, "Countertops"				X
CSI Section 210553, "Identification for Fire Suppression Piping and Equipment"				X
CSI Section 211313, "Wet-Pipe Sprinkler Systems"		X		
CSI Section 211319, "Preaction Sprinkler Systems"		X		
CSI Section 212200, "Clean-Agent Fire-Extinguishing Systems"		X		
CSI Section 220553, "Identification for Plumbing Piping and Equipment"				X
CSI Section 221119, "Domestic Water Piping Specialties"				X
CSI Section 224213, "Commercial Water Closets and Urinals"		X		X
CSI Section 224216, "Commercial Lavatories and Sinks"		X		X
CSI Section 224713, "Drinking Fountains"		X		X
CSI Section 230519, "Meters and Gages for HVAC Piping"				X
CSI Section 230553, "Identification for HVAC Piping and Equipment"				X

Special Provision (including CSI-formatted Specifications)	Warranties	Spare Parts	Training	Operation and Maintenance Manuals
CSI Section 230900, "Instrumentation and Control for HVAC"	X		X	X
CSI Section 232116, "Hydronic Piping Specialties"				X
CSI Section 232300, "Refrigerant Piping"				X
CSI Section 233300, "Air Duct Accessories"		X		
CSI Section 233423, "HVAC Power Ventilators"		X	X	X
CSI Section 237313, "Modular, Indoor, Central-Station Air Handling Units"	X	X	X	X
CSI Section 238126, "Split-System Air-Conditioners"	X	X	X	X
CSI Section 238233, "Convectors"				X
CSI Section 260923, "Lighting Control Devices"				X
CSI Section 262415, "Static Uninterruptible ... Switch"	X		X	X
CSI Section 262416, "Panelboards"		X		X
CSI Section 262728, "Track Busway"	X		X	X
CSI Section 262813, "Fuses"		X		X
CSI Section 262816, "Enclosed Switches and Circuit Breakers"		X		X
CSI Section 265119, "LED Interior Lighting"	X	X		X
CSI Section 265219, "Emergency and Exit Lighting"	X			X
CSI Section 275119, "Sound Masking Systems"	X		X	X
CSI Section 276270, "Central Radio System"			X	X
CSI Section 282300, "Video Surveillance"	X			X
CSI Section 283100, "Fire Alarm System"	X	X	X	X

NOTICE TO CONTRACTOR - HAZARDOUS MATERIALS INVESTIGATIONS

Limited hazardous materials site investigations have been conducted on the ground floor Highway Ops, Daycare, Nurse's Area and Cafeteria Areas at the ConnDOT Office Building, 2800 Berlin Turnpike, Newington, Connecticut subject to the Highway Operations Renovation Project. The scope of inspections were limited to the representative components projected for impact.

Results of the survey identified no lead-based-paint (LBP) to be present in the areas subject to the areas to be renovated.

Results of the survey identified no asbestos-containing-materials (ACM) to be present in the areas subject to the areas to be renovated.

Items/components containing Universal Waste (UW), Connecticut Regulated Waste (CRW) and Low Level Radioactive Waste (LLRW) were found in the areas to be renovated.

The Contractor is hereby notified that these hazardous materials requiring special management or disposal procedures will be encountered during various construction activities conducted within the project limits. The Contractor will be required to implement appropriate health and safety measures for all construction activities impacting these materials. These measures shall include, but are not limited to, air monitoring, engineering controls, personal protective equipment and decontamination, equipment decontamination and personnel training. **WORKER HEALTH AND SAFETY PROTOCOLS WHICH ADDRESS POTENTIAL AND/OR ACTUAL RISK OF EXPOSURE TO SITE SPECIFIC HAZARDS ARE SOLELY THE RESPONSIBILITY OF THE CONTRACTOR.**

The Department, as Generator, will provide an authorized representative to sign all manifests and waste profile documentation required by disposal facilities for disposal of hazardous materials.

The Sections which shall be reviewed by the Contractor include, but are not limited to, the following:

- Item No. 0101143A – Handling and Disposal of Regulated Items

The Contractor is alerted to the fact that a Department environmental consultant may be on site for abatement and related activities, to collect environmental samples (if necessary), and to observe site conditions for the State.

Information pertaining to the results of the limited hazardous materials investigation discussed can be found in the document listed below. This document shall be available for review electronically.

- Pre-Renovation Investigative Survey for Hazardous Building Materials, 2800 Berlin Turnpike, Highway-Ops Center, Newington, Connecticut, Project 93-210, November 2017.

NOTICE TO CONTRACTOR - FEDERAL WAGE DETERMINATIONS (Davis Bacon Act)

The following Federal Wage Determinations are applicable to this Federal- Aid contract and are hereby incorporated by reference. During the bid advertisement period, it is the bidder's responsibility to obtain the latest Federal wage rates from the US Department of Labor website, as may be revised 10 days prior to bid opening. Any revisions posted 10 days prior to the bid opening shall be the wage determinations assigned to this contract.

Check Applicable WD# (DOT Use Only)	WD#	Construction Type	Counties
X	CT1	Highway	Fairfield, Litchfield, Middlesex, New Haven, Tolland, Windham
	CT2	Highway	New London
	CT3	Highway	Hartford
	CT5	Heavy Dredging (Hopper Dredging)	Fairfield, Middlesex, New Haven, New London
	CT6	Heavy Dredging	Statewide
	CT13	Heavy	Fairfield
	CT14	Heavy	Hartford
	CT15	Heavy	Middlesex, Tolland
	CT16	Heavy	New Haven
	CT17	Heavy	New London
	CT26	Heavy	Litchfield, Windham
	CT18	Building	Litchfield
	CT19	Building	Windham
	CT20	Building	Fairfield
	CT21	Building	Hartford
	CT22	Building	Middlesex
	CT23	Building	New Haven
	CT24	Building	New London
	CT25	Building	Tolland
	CT4	Residential	Litchfield, Windham
	CT7	Residential	Fairfield
	CT8	Residential	Hartford
	CT9	Residential	Middlesex
	CT10	Residential	New Haven
	CT11	Residential	New London
	CT12	Residential	Tolland

The Federal wage rates (Davis-Bacon Act) applicable to this Contract shall be the Federal wage rates that are current on the US Department of Labor website (<http://www.wdol.gov/dba.aspx>) as may be revised 10 days prior to bid opening. The Department will no longer physically include revised Federal wage rates in the bid documents or as part of addenda documents. These applicable Federal wage rates will be incorporated in the final contract document executed by both parties.

If a conflict exists between the Federal and State wage rates, the higher rate shall govern.

To obtain the latest Federal wage rates, go to the US Department of Labor website (link above). Under Davis-Bacon Act, choose "Selecting DBA WDs" and follow the instruction to search the latest wage rates for the State, County and Construction Type.

SECTION 1.20 - GENERAL CLAUSES FOR FACILITIES CONSTRUCTION

1.20-1.05.02— Facilities Construction – Contractor Submittals:

Replace #1, #2, and #3.

1. General: If the plans prepared by the Department do not show complete details, they will show the necessary dimensions and preliminary details, which when used along with the other Contract documents, will enable the Contractor to prepare submittals necessary to complete the Contract work.

The Contractor is required to prepare submittals as Portable Document Format (PDF) files using Bluebeam Revu.

The Contractor is also required to acquire and maintain access to the Department’s Bentley ProjectWise data management system portal. The minimum recommended internet speed is 25MB/sec. For reference, the Department’s internet speed is 1 GB/sec.

The Contractor shall submit a “CT DOT ProjectWise – New User Form” to request user names and passwords. The Department will permit Web-based access and no more than 2 users for the Contractor.

The entry/log-in procedure is described in Section 3.2 of the CT DOT Digital Project Development Manual.

2. Submittal Preparation and Processing: The Contractor shall:

- (a) Coordinate preparation and processing of submittals with performance of construction activities;
- (b) Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay;
- (c) Coordinate each submittal with fabrication, purchasing, testing, delivery, and other submittals and related activities that require sequential activity;
- (d) Provide complete submittal packages as multi-page PDF’s (Working Drawings, Shop Drawings, Product Data, Product Samples, and Quality Assurance Submittals, as applicable) for related elements of Project work for a concurrent review of all information. Incomplete submittal packages will be returned to the Contractor without being reviewed. Electronic PDF packages shall be limited to 75 MB unzipped; larger PDF packages will need to be broken up.

The Contractor shall allow at least 21 calendar days for initial submittal review by the submittal reviewer, and allow additional time for such review if processing must be delayed to permit coordination with subsequent submittals. If a subsequent submittal is necessary, the Contractor shall allow at least 21 additional calendar days for processing each subsequent submittal. The submittal reviewer reserves the right to withhold action on a submittal if coordination with other submittals is necessary, until all related submittals are received. The submittal reviewer will promptly inform the Contractor when a submittal being processed must be delayed for such

coordination.

The Contractor shall allow at least 28 calendar days for outside agency review of any submittal requiring their approval, including but not limited to the following: any utility, FTA, any railroad, DEEP, U.S. Coast Guard, Army Corps of Engineers, FM Global, and any Commissioning Authority.

The Engineer will not authorize an extension of Contract time because of the Contractor's failure to transmit submittals to the submittal reviewer or outside agencies sufficiently in advance of the work to permit processing.

The Contractor shall be limited to one acceptable submittal per product. Once a product has been accepted either as originally specified, or as an "Or Equal" to the product specified, the Contractor may elect to submit a subsequent product for consideration, but the Contractor shall be required to reimburse the Department for all costs associated with reviewing the subsequent request.

The Contractor shall attach a Submittal Transmittal Form to the beginning of each PDF submittal package. A blank Submittal Transmittal Form is located in ProjectWise "01.0 – Projects-Active" under the subfolder "120_Contractor_Submittals (PDF)" under the project number main folder. This form will be used for the Contractor to digitally certify that "Having reviewed this submittal, I certify that it is complete, accurate, coordinated in all aspects of the item being submitted and conforms to the requirements of the Contract in all respects, including all Federal requirements such as "Buy America", except as otherwise noted." The digital certification process is detailed in Section 2 of the CT DOT Digital Project Development Manual.

3. Transmittal of Submittals: The digitally certified PDF submittal package shall be uploaded into ProjectWise "01.0 – Projects-Active" under the subfolder "120_Contractor_Submittals (PDF)" under the project number main folder. The upload process is detailed in Section 3.2.1-3 of the CT DOT Digital Project Development Manual. The submittal reviewer will not act on submittals received in any other manner.

The Contractor shall attribute the submittal packages in ProjectWise using the following the following attributes and naming conventions:

- a) Discipline: CTR
- b) Main Category: CONTRACTOR
- c) Sub Category: SUBMITTAL
- d) Label: "XXX-Spec Reference-##"

- 1. "XXX" is the chronological submittal number created by the Contractor starting at 001.
- 2. "Spec Reference" is the 7-digit Contract Item No. (no "A" shall be included) for individual Contract items or is the 6-digit CSI Section number preceded by a "C" (making it a total of 7 digits) for the MLSI.
- 3. "##" is the submission attempt (01, 02, 03, etc.) of the submittal.

- e) Description: Brief description of submittal content labeled “Submittal – *submittal content.*”

The first submission for a particular item is the “01” submittal. Subsequent resubmittals (02, 03, etc.) are transmitted as described above only for those submittals or portions thereof returned to the Contractor with a “Revise and Resubmit” or “Rejected” disposition. The chronological submittal number shall not be revised on a resubmittal.

After uploading an initial or subsequent submittal, the Contractor shall provide e-mail notification to submittal reviewers and other key personnel at their business e-mail address that the submittals have been uploaded and are available for review. The Contractor shall provide a web link to the PDF submittal within their e-mail notification. The Contractor shall include the following information in the notification e-mail subject line in this order: *Project Number - “XXX-Spec Reference-##” – “Description.”* The submittal review time begins when the submittal reviewer is notified by e-mail.

In the 4th paragraph of subsection e, insert “color” between the phrase “2 copies” in each location.

11. Submittal Reviewer’s-Action:

Delete the next to last paragraph “The Contractor shall mark up one set ... as a “Record Document.” and replace it with:

“The Contractor shall mark up one set of Working Drawings (including any related calculations), Shop Drawings, and Coordination Drawings and retain them as a “Record Document.”

1.20-1.05.05—Facilities Construction – Cooperation by Contractor:

Delete in its entirety and replace with:

“The Contractor will be supplied by the Department with copies of the plans.

The Contractor shall maintain in good order, in a secure, fire-resistant location at the Project site, 2 copies of all plans, Special Provisions (including CSI-formatted specifications within a particular Special Provision), Addenda, submittals, Construction Orders, and other modifications, schedules and instructions. Both sets shall be available to the Engineer at all times. The Contractor shall keep one set clean of all markings. The Contractor shall mark one set of these documents to record all changes made during construction. The Contractor shall keep these documents current. The Contractor shall not permanently conceal any work until the required information has been recorded. The Engineer may withhold payments due to the Contractor should they fail to keep these documents current.

Record Drawings: The Contractor shall maintain a complete set of Record Drawings by maintaining a clean, undamaged set of blue or black line prints of Contract drawings (original

Contract plans as modified by Addenda and Construction Orders), Working Drawings (including any related calculations), Shop Drawings, and Coordination Drawings. The Contractor shall mark whichever drawings within the set that is ~~are~~ most capable of showing conditions fully and accurately where the actual installation varies substantially from the Project work as originally shown. The Contractor shall include hyperlinks on the Contract drawings to cross-reference to the related Working Drawings, Shop Drawings, Coordination Drawings, as well as RFI's and RFC's. The Contractor shall give particular attention to concealed elements that would be difficult to measure and record at a later date. The Contractor shall (1) mark record sets with red erasable pencil, (2) use other colors to distinguish between variations in separate categories of the Project work, (3) mark new information that was not shown on Contract plans, Working Drawings, Shop Drawings, or Coordination Drawings, (4) note related Addenda and construction order dates where applicable.

Record Specifications: The Contractor shall maintain one complete copy of the Record Specifications, including related Addenda, construction orders and modifications issued in printed form during construction. The Contractor shall (1) mark these documents to show substantial variations in actual Project work performed in comparison with the text of the Specifications and modifications, (2) take care to show clearly on these documents any selected options and information on concealed construction that would be difficult to view at a later date, (3) note related record drawing information and Product Data.

Record Reports: The Contractor shall maintain one binder of all miscellaneous records such as manufacturer startup reports, test reports, and Building and Fire Code inspection reports required by other Contract Provisions (including CSI-formatted Specifications within a particular Special Provision). The miscellaneous records shall be arranged systematically according to the organization of the Contract provisions.

Record Survey: The Contractor shall submit a Record Survey in accordance with other Contract"

1.20-1.05.07—Facilities Construction – Coordination with Work by Other Parties:

Add the following after the last paragraph:

“The Contractor is hereby advised that all areas outside of the Project work areas shall remain fully operational during all phases of construction. The Contractor shall cooperate with the Engineer during construction operations to minimize conflicts and facilitate Engineer, Department personnel, and the public’s occupancy.

The Contractor is advised that they shall grant access, including working within the Project work areas, to Department personnel, contractors, and vendors that are not directly involved in the construction of the project along with contractors and vendors that are directly involved in the construction of this Contract:

1. Murphy Security will be involved in the Project to provide Fire Watch Services when portions of any sprinkler system are out of service.
2. Siemens will be involved in the Project through DAS #01PSX0160AA with the Owner for preventative maintenance of the existing HVAC systems, sprinkler systems, fire alarm, access control systems, and CCTV systems. Siemens will also be involved in the integration of Project work into the existing systems, including suppression agent interconnection.
3. Owner Contractor (Specialized Furniture Vendor) will be involved in the Project to install operator consoles through GSA #GS-03F-0037M, #GS-03F-0124Y, and #GS-03F-0010R
4. Owner Contractor (Office Furniture Vendor) will be involved in the Project to furnish and install furniture through DAS #15PSX0041 and #16PSX0171.
5. Owner Contractors will be involved throughout the entire Project to ensure their system needs are met. These Owner Contractors will be actively working within the project areas during Phase 3B which is concurrent with Phase 3A activities. Notwithstanding Contractor troubleshooting and repair of Contract work, the Owner Contractors will be the only contractors working within the project areas during Phase 3C.

The following table is provided to clarify the work required to be performed by the Contractor and by Owner Contractors.

Elements and Responsibilities

Item # Or CSI Section	Element	93-210 Contractor	Owner Contractor (System Integrator) DAS #15PSX0227	Owner Contractor (ATMS Integrator) Various DAS #'s	Notes
1008700A	4" Multiduct Conduit	X			
1108539A	Modify Existing Operations Center System; Optical Fiber Termination Patch Panels, Optical Fiber Cable Single Mode Loose Buffer Tube Cable, 288 fiber, Fiber Optic Splice Enclosure, Relocation of IMS Fiber Optic Cable	X			Intelligent Transportation Systems (ITS) Inside Plant Coax / Network cabling
1108504A	Equipment Racks	X	X		Includes cable management and PDUs Contractor will deal with all CAT 6A terminations in the racks, except for coax. Needs to provide cable testing certification for CAT 6A cable. System Integrator will provide coax termination and certification of end-to-end coax links. System Integrator will also provide as-builts for rack-to-rack cabling once all rack equipment has been installed.
1108745A	Video and Graphics Wall Equipment, Audiovisual Equipment and Control	X			Includes Video Graphics Display Items and Display processor. Must be integrated by a specialty subcontractor to the Contractor with sufficient experience and qualifications in the delivery of similar scope projects
270526, 271313, 271513	Communications Wiring	X			Voice and Data
276270	Central Radio System	X			Must be integrated by a specialty subcontractor to the Contractor with sufficient experience and qualifications in the delivery of similar scope projects

All other CSI Sections	Various	X			
n/a	Video Management System, Video Mux/Demux, Video Encoders/Decoders, Terminal Port Servers, Port Sharing Device, Ethernet Switches, Audio Distribution System		X		
n/a	Console Workstations, ITS Servers, Storage Area Network			X	PC, keyboard, mouse, monitors at Console Workstations

Furthermore, the Contractor is advised that the construction of Project No. 93-220, Newington Headquarters Improvements, is anticipated to start in 2019.

The Contractor, other contractors and vendors, the Engineer, the Department’s Highway Operations personnel, and other Department personnel will coordinate construction operations and Department operations on a daily basis, if necessary. All entities shall attend all construction meetings.”

1.20-1.05.08— Facilities Construction – Schedules and Reports:

Delete the first sentence and replace with the following:

“Transmittals of Schedules: The schedule package shall be uploaded into ProjectWise “01.0 – Projects-Active” under the subfolder “115_Contractor_Schedules” under the project number main folder. The specific work flow to do so will be distributed at the Preconstruction Meeting.

The Contractor shall attribute the submittal packages in ProjectWise using the following the following attributes and naming conventions:

- a) Discipline: CTR
- b) Main Category: CONTRACTOR
- c) Sub Category: SCHEDULE
- d) Label: “Project Number - Schedule #XX - Date”
- e) Description: “Schedule #XX – Date”

After uploading a schedule (baseline bar chart, monthly update, biweekly, or recovery), the Contractor shall provide e-mail notification to submittal reviewers and other key personnel at their business e-mail address that the submittals have been uploaded and are available for review. The Contractor shall provide a web link to the schedule within their e-mail notification. The Contractor shall include the following information in the notification e-mail subject line in this order: “Project Number - Schedule #XX - Date”

When a project coordinator is not required by the Contract the following shall apply:”

1.20-1.05.23 – Facilities Construction – Requests for Information (RFI’s) and Requests for Change (RFC’s):

Delete the first paragraph and replace with the following:

“The Contractor shall upload all RFIs and RFCs into ProjectWise “01.0 – Projects-Active” under the subfolder “121_Contractor RFIs and RFCs” under the project number main folder. The specific work flow to do so will be distributed at the Preconstruction Meeting. The Contractor shall attribute the RFIs and RFCs in ProjectWise using the following the following attributes and naming conventions:

Discipline: CTR

Main Category: CONTRACTOR

Sub Category: RFI or RFC

Label: “Project Number – RFI #XX - Date” or “Project Number – RFC #XX - Date”

Description: “RFI #XX - Date” or “RFC #XX - Date”

After uploading the RFIs and RFCs, the Contractor shall provide e-mail notification to the Engineer at their business e-mail address that the submittals have been uploaded and are available for review. The Contractor shall provide a web link to the RFI or RFC within their e-mail notification. The Contractor shall include the following information in the notification e-mail subject line in this order: “*Project Number - RFI #XX - Date*” or “*Project Number - RFC #XX - Date.*”

The Engineer will forward the RFI or RFC to the Designer for review. Upon receipt of an RFI or RFC, the Designer will attempt to determine if additional information is required from the Contractor to respond to the RFI or RFC and request said information from the Engineer.”

1.20-1.06.08 – Facilities Construction – Warranties

Delete paragraph 8 starting “Prior to the date for the Substantial Completion Inspection to the end of the Article.

“Prior to the date of the Substantial Completion Inspection, the Contractor shall compile each required warranty, properly executed by the Contractor or any other required party. The warranties shall be uploaded into ProjectWise “01.0 – Projects-Active” under the subfolder “122_Contractor Closeout Documents” under the project number main folder. The specific work flow to do so will be distributed at the Preconstruction Meeting. The Contractor shall attribute the warranties in ProjectWise using the following the following attributes and naming conventions:

Discipline: CTR

Main Category: CONTRACTOR

Sub Category: WARRANTIES

Label: “Project Number – Warranties”

Description: “Warranties”

After uploading the warranties, the Contractor shall provide e-mail notification to submittal reviewers and other key personnel at their business e-mail address that the warranties have been uploaded and are available for review. The Contractor shall provide a web link to the zipped

folder within their e-mail notification. The Contractor shall include the following information in the notification e-mail subject line in this order: “*Project Number - Warranties.*”

The Contractor shall submit warranties in PDF format, assembling the complete warranty submittal package into a single electronic PDF file with bookmarks enabling navigation to each item and providing a bookmarked table of contents at beginning of document. The Contractor shall place the warranty documents in an orderly sequence based on the organization of the Contract provisions (including specific CSI-formatted specifications contained within a particular Special Provision). Electronic PDF packages shall be limited to 75 MB unzipped; larger PDF packages will need to be broken up.

The Contractor shall include a description of the product or installation, including the name of the product, and the name, address and telephone number of the Contractor or pertinent subcontractor.

The Contractor shall furnish to the Department a written warranty for all Project work accompanied by a cover letter with the following contents:

<p>[Addressed to:]</p> <p>Commissioner of Transportation Department of Transportation P.O. Box 317546 Newington, Connecticut 06131-7546</p> <p>Project Title and Number</p> <p>[We] hereby warrant all materials and workmanship for all work performed under this Contract for a period of one (1) year from [date of issuance of C.O.C.] against failures of workmanship and materials in accordance with the Contract. Furthermore, as a condition of this warranty, [we] agree to have in place all insurance coverage identified in the Contract for the performance of any warranty work.</p> <p>[Signature:] [Name of authorized signatory] [Title]</p>
--

Upon determination by the Engineer that Project work covered by a warranty has failed, the Contractor shall replace or rebuild the work to an acceptable condition complying with Contract requirements. The Contractor is responsible for the cost of replacing or rebuilding defective construction or components and those which may have needed to be damaged or removed in order to cure the defective work including costs of material, equipment, labor, and material disposal, regardless of whether or not the State has benefited from use of the work through a portion of its anticipated useful service life. The Contractor shall respond to the Project Site when Project work covered by a warranty has failed within 3 calendar days, unless in the Engineer’s opinion said failure is deemed to be an emergency, in which case the Contractor shall respond to the Project Site as directed by the Engineer.

When Project work covered by a warranty has failed and been corrected by replacement or

rebuilding, the Contractor shall reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the time that remains on the original warranty period at the time of the failure.”

1.20-1.08.01—Facilities Construction – Transfer of Work or Contract:

Replace “25%” with “30%” in the first sentence.

1.20-1.08.03—Facilities Construction – Prosecution of Work:

Add the following as a new section 6:

“6. Project Phasing: The Contractor is responsible for developing its own phasing plan for the Engineer’s approval for Project work. A proposed outline phasing plan is included on the plans. This phasing plan does not fully describe all elements of the Project work. All proposed deviations from the proposed outline phasing plan require the approval of the Engineer. Any Contractor proposed deviation shall maintain an equivalent level of occupant protection with minimal disruptions to said occupants. The Contractor shall schedule the remaining Project work accordingly.”

1.20-1.08.04—Facilities Construction – Limitation of Operations:

Add following the last paragraph.

“Use of Building:

The Contractor shall confine its operations to areas shown on plan sheets AS-003 to AS-010. Other areas are not to be disturbed unless otherwise noted.

The Contractor shall:

1. Take all precautions necessary to protect the building during the construction period.
2. Provide partition walls/dust curtains/covers or other materials acceptable to the Owner and the Engineer to keep Owner occupied areas clean during the Project.
3. Turn over all salvage materials to the Owner and promptly remove all other materials from the Project Site.
4. Perform a daily cleanup of all Project-related debris and ensure that all Owner occupied spaces remain “broom clean.”
5. Vacuum debris from all plenum spaces affected by the performance of Project work.
6. Repair at its own expense any damage caused by construction operations to the building unless said damage is scheduled as Project work. This includes all interior finishes including, but not limited to, the following: walls, doors and frames, flooring including ramps and stairs, suspended ceiling tiles, and suspended ceiling grid. New materials shall match existing materials as determined by the Engineer.

Contractor Employee Building Access, Badging, and Building Security:

All Contractor and subcontractor employees shall “sign-in” with the Engineer and obtain a visitor’s badge at the start of each work day and they shall “sign-out” with the Engineer when they turn in the visitor’s badge at the end of each work day. The Engineer will maintain a list of employees that are issued badges, including the time of issuance and return, on a daily basis. This list may be used by the Engineer or the Owner to determine who was on the Project Site on a particular day. The Contractor shall ensure that all employees wear and properly display their badges and that no employees will be granted access to the building until issued a badge. The Contractor’s Project Superintendent is responsible for ensuring that all badges are turned in daily. A \$10 replacement fee will be charged for each lost badge. Failure of any employee to comply with these requirements will result in the removal of the employee by the Engineer from the Project Site after only one warning.

The Engineer will issue a DOT Card Reader Badge and a building key to the Contractor Project Superintendent at the start of each work day and collect them at the end of each work day. All Contractor and subcontractor employees shall enter the building through the entrance directed by the Engineer.

The Contractor is responsible for maintaining building security at all times in order to prevent theft of or damage to Owner’s property or access to unauthorized personnel. The Contractor shall not prop doors open or create other situations that compromise building security. Should the Contractor fail to maintain security even once, the Contractor may be directed by the Engineer to hire the services of a security guard from the Owner’s Contract provider at no additional cost to the Engineer.

Building Occupancy:

The building occupancy will be classified as “Normal Occupancy” or “Reduced Occupancy” as defined herein:

1. Normal Occupancy: Monday to Friday from 7:00 AM to 5:00 PM.
2. Reduced Occupancy:
 - a. Weeknights between the hours of 5:30 PM and 6:45 AM the following morning.
 - b. Weekends from 5:30 PM Friday through 6:45 AM Monday.

Additionally:

1. Cafeteria staff work day begins at 5:30 AM on Monday and at 6:30 AM on Tuesday to Friday.
2. Security staff work day ends at 10:30 PM Monday to Friday. Security will arm the building security system for the entire building except for the Ground Floor areas between HOC, the bathrooms, corridors, and vending areas.
3. Custodial staff work day ends at 10:30 PM Monday to Friday. This includes buffing the floor on the ground level and moving materials across the ground floor lobby/common area for much of the night.

4. The Highways Operations Center (HOC) is responsible for directing the Department's activities 24-7-365 so the HOC, the parking garage, and the path of travel between the HOC and the parking garage, including the north elevator, are occupied during reduced occupancy.

Project Work Restrictions:

Work during Reduced Occupancy: The Contractor shall perform the following Project work when the building is considered to have "reduced occupancy" unless otherwise approved by the Engineer:

1. Pre-Construction Phase investigations above ceilings and below access floors.
2. Noisy or dusty activities such as shooting into concrete floors, saw cutting, drilling, or jack hammering concrete.
3. Odorous work or work with VOC-emitting products such as carpet, paint, caulks, and sealants.
4. Work associated with the relocation of the existing fire department connection (FDC) piping within Area A such that the FDC is back in service within 8 hours of being taken out of service.
5. Testing of any system such as fire alarm, sprinkler, and FM200 that may cause the evacuation of the building.
6. Any other work that negatively impacts the ability of the building occupants from performing their assigned duties.

The Contractor may submit alternate plans depicting their methods of accomplishing this work under normal occupancy. The plan shall include details such as protective staging, overhead protection, barricades, and required circulation/egress pathways to protect the building occupants. Any plan submitted will be reviewed by the Engineer, the Designer, the Owner, the Department's authority having jurisdiction for building code compliance, and OSFM for fire code compliance. The decision of this group to accept, modify, or reject the plan will be final.

Specific Work Restrictions: The Contractor shall perform the following Project work as described, unless otherwise approved by the Engineer:

1. Existing UPS: The existing UPS shall be taken out of service only one time and only on a Tuesday or a Wednesday from 10 AM to 2 PM.
2. Transfer of operations from the Highway Operations Center (HOC) in Area B to the HOC in Area starting Phase 3C will only be permitted on a Tuesday or a Wednesday from 10 AM to 2 PM.

Work within the Corridors: The Contractor shall not impede pedestrian traffic within the corridors, including the north elevator, between the Highway Operations Center and the parking garage, unless approved by the Engineer.

The Contractor shall not impede pedestrian traffic within the corridors between the north and south elevators Monday to Friday between the hours of 7:00 AM until 8:45 AM, from 9:30 AM until 10:30 AM, from 11:30 AM until 1:15 PM, and from 2:00 PM until 3:00 PM.

The Contractor shall erect scaffolding in the corridors and maintain all necessary safeguards to protect the public and Department personnel from Project work and falling debris. The Contractor shall post danger signs warning against the hazards of construction.

The Contractor shall phase the work to minimize the amount of time that the scaffolding is in place and that the ceilings are open.

Fire Alarm System Work: The Contractor may request to take portions of the building fire alarm system out of service only with the approval of the Engineer, the Owner, and the Department's authority having jurisdiction for building code compliance, and OSFM for fire code compliance. The request shall describe what work will be performed, the anticipated duration that the system will be out of service, and what precautions they will take (such as be radio equipped personnel to communicate directly with DOT Security). The decision of this group to accept, modify, or reject the request will be final. Should the Contractor be permitted to take the fire alarm system out of service, they shall log the following minimal information: Notification to Monitoring Service that the Alarm will be Out of Service, Out of Service Start Time, In-Service Time, and Notification to Monitoring Service that the Alarm is In Service. In no instance shall the fire alarm system be out of service when the occupancy of the building is reduced.

The Contractor is hereby advised that the accidental activation of the building fire alarm system will not be tolerated. The Contractor is to take all necessary precautions to prevent this from occurring and shall inform, and work with, building maintenance and security personnel when their work may impact the fire alarm system. The Contractor may cover the smoke detectors above and below the floors to prevent activation, but shall also take precaution to ensure that dust is not allowed to settle in areas that may cause a future activation.

1.20-1.08.12—Facilities Construction - Semi-Final, Substantial Completion, and Final Inspections:

Delete 1. Semi-Final Inspection and replace with the following:

“General: Based on the Project Phasing, the Contractor shall anticipate multiple inspections on this Project.

1. Semi-Final Inspection: If the Contractor has completed all physical work for the particular Phase, a Semi-Final Inspection will be scheduled as soon as practical after the Contractor submits the following:

- (1) Record Drawings, Record Specifications, miscellaneous records, and Contractor Asbestos Certification Letter as referenced in Article 1.20-1.05.05 (submit during Phase 4 for the entire Project);

- (2) preliminary test/adjust/balance records including the air and water balance report (submit during Phase 1, Phase 2, and Phase 4);
- (3) one interim copy of all Operation and Maintenance Manuals as referenced in Article 1.20-1.08.14 (submit during Phase 1, Phase 2, Phase 3A, and Phase 4);
- (4) a list of all required training along with the entities who will provide the training and estimated time frames for each session (submit during Phase 1, Phase 2, Phase 3A, and Phase 4);
- (5) a list of all spare parts and salvage materials to be turned over to the Owner (submit during Phase 4 for the entire Project).

The Engineer, Designer, Building and Fire Code Officials, and the Owner will conduct inspections to prepare “Punch Lists” of unfulfilled, substandard, or incomplete items. During these inspections, the Contractor shall have all technicians necessary to demonstrate the complete operation of all systems on site. Examples of such systems include, but are not limited to, the following: boiler, HVAC, fire alarm, and building automation. Results of the completed inspections will form the basis of requirements for the Substantial Completion Inspections. The Engineer reserves the right to issue the C.O.C. after the Semi-Final Inspection if the requirements of the Substantial Completion Inspection are met and there are no Building Code or Fire Code compliance issues or any major “Punch List” items that would adversely affect the tenants of the facility after moving in. The Engineer will advise the Contractor of the construction that shall be completed before the issuance of the C.O.C.

1.20-1.08.14 – Facilities Construction – Acceptance of Project

Delete 4. Operation and Maintenance Manuals down to “Product Maintenance Manual” and replace with the following:

“4. Operation and Maintenance Manuals: Prior to the date of each Semi-Final Inspection for Phase 1, Phase 2, Phase 3A, and Phase 4, the Contractor shall compile operation and maintenance manuals in the form of instructional manuals for use by the Owner. The operation and maintenance manuals shall be uploaded into ProjectWise “01.0 – Projects-Active” under the subfolder “122_Contractor Closeout Documents” under the project number main folder. The specific work flow to do so will be distributed at the Preconstruction Meeting. The Contractor shall attribute the operational and maintenance manual packages in ProjectWise using the following the following attributes and naming conventions:

Discipline: CTR

Main Category: CONTRACTOR

Sub Category: OPERATION AND MAINTENANCE MANUALS

Label: “Project Number – Operation and Maintenance Manuals - Description”

Description: “Operation and Maintenance Manuals - Description”

After uploading the manuals, the Contractor shall provide e-mail notification to submittal reviewers and other key personnel at their business e-mail address that the submittals have been uploaded and are available for review. The Contractor shall provide a web link to the zipped folder manuals within their e-mail notification. The Contractor shall include the following

information in the notification e-mail subject line in this order: “*Project Number - Operation and Maintenance Manuals – Description.*”

The Contractor shall submit manuals in the form of a multiple file composite electronic PDF file for each manual type required using electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size. Electronic PDF packages shall be limited to 75 MB unzipped; larger PDF packages will need to be broken up.

For each manual, the Contractor shall:

- (a) Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.
- (b) Provide a title page as the first page of each manual with the following information: subject matter covered by the manual; Contract number and title; date of submittal; name, address, and telephone number of the Contractor; and cross-reference to related systems in other sections.
- (c) Provide a table of contents, arranged systematically according to the organization of the Contract provisions (including specific CSI-formatted specifications within a particular Special Provision).
- (d) Provide a general information section immediately following the table of contents, listing each product included in the manual, identified by product name. The Contractor shall list the name, address, and telephone number of the subcontractor, the maintenance contractor, and the local source for replacement parts and equipment for each product.
- (e) Include manufacturer's standard data and mark each sheet to identify each part or product included in the Project, identify each product using appropriate references from the Contract, and delete references to information that is not applicable. The use of project record documents as part of operation and maintenance manuals is not permitted.
- (f) Prepare supplementary text to provide operation and maintenance information when the manufacturer's standard data is not available or the data is insufficient and the information is necessary for proper operation and maintenance of equipment or systems, organize text in a consistent format under separate headings for each procedure, and provide a logical sequence of instruction for each operation or maintenance procedure.
- (g) Provide drawings where necessary in order to supplement manufacturer's data to illustrate the relationship of component parts of equipment or systems or to provide control or flow diagrams. The Contractor shall coordinate these drawings with information contained in project record drawings to ensure correct illustration of the completed installation. The use of Project record documents as part of operation and maintenance manuals is not permitted.
- (h) Provide estimated life cycle costs to maintain each product included in the manual to reach maximum useful life (i.e. annual, mid-life overhaul, end of life overhaul, or programmed interval replacement).”

Delete the last 2 paragraphs of 5. Training (“The Contractor shall submit ... owner for unlimited reproduction.”) and replace with the following:

“The Contractor shall video record each training session.”

Add New Section:

“1.20-1.10.09 – Facilities Construction – Compliance with Existing Site Permits

The Contractor shall conduct its operations in conformance with the permit requirements established by Federal, State and municipal laws and regulations.

In addition to permits obtained by the Department specifically for the Project, facilities have existing site specific permits and regulatory requirements related to site operational activities. The specific permits and regulatory requirements will be identified in the Contract. The Contractor shall become familiar with these requirements and shall conduct their operations in conformance with these requirements.

The Contractor shall be responsible for, and hold the State harmless from, any penalties or fines assessed by any authority due to the Contractor’s failure to comply with any term of an applicable environmental permit.”

ON-THE-JOB TRAINING (OJT) WORKFORCE DEVELOPMENT PILOT

Description

To provide construction industry related job opportunities to minorities, women and economically disadvantaged individuals; and to increase the likelihood of a diverse and inclusive workforce on Connecticut Department of Transportation (ConnDOT) projects.

All contractors (existing and newcomers) will be automatically placed in the Workforce Development Pilot. Standard OJT requirements typically associated with individual projects will no longer be applied at the project level for new projects. Instead, these requirements will be applicable on an annual basis for each contractor performing work on ConnDOT projects.

The OJT Workforce Development Pilot will allow a contractor to train employees on Federal, State and privately funded projects located in Connecticut. However, contractors should give priority to training employees on ConnDOT Federal-Aid funded projects.

Funding

The Department will establish an OJT fund annually from which contractors may bill the Department directly for eligible trainee hours. The funds for payment of trainee hours on federal-aid projects will be allocated from the ½ of 1% provided for OJT funding, and will be based on hours trained, not to exceed a maximum of \$25,000.00 per year; per contractor.

Minorities and Women

Developing, training and upgrading of minorities, women and economically disadvantaged individuals toward journeyman level status is the primary objective of this special training provision. Accordingly, the Contractor shall make every effort to enroll minority, women and economically disadvantaged individuals as trainees to the extent that such persons are available within a reasonable area of recruitment. This training commitment is not intended, and shall not be used, to discriminate against any applicant for training whether a member of a minority group or not.

Assigning Training Goals

The Department, through the OJT Program Coordinator, will assign training goals for a calendar year based on the contractor's past two year's activities and the contractor's anticipated upcoming year's activity with the Department. At the beginning of each year, all contractors eligible will be contacted by the Department to determine the number of trainees that will be assigned for the upcoming calendar year. At that time, the Contractor shall enter into an agreement with the Department to provide a self-imposed on-the-job training program for the calendar year. This agreement will include a specific number of annual training goals agreed to by both parties. The number of training assignments may range from one (1) to six (6) per

contractor per calendar year. Each January, a summary of the trainees required and the OJT Workforce Development Pilot package will be sent to participating contractors. The number of trainees assigned to each contractor in the summary will increase proportionately not to exceed 6, as shown in the following table. This package will also be provided to contractors as they become newly eligible for the OJT Workforce Development Pilot throughout the remainder of the year. Projects awarded after September 30 will be included in the following year's Program.

The dollar thresholds for training assignments are as follows:

\$4.5 – 8 million=	1 trainee
\$ 9 – 15 million=	2 trainees
\$16 – 23 million=	3 trainees
\$24 – 30 million=	4 trainees
\$31 – 40 million=	5 trainees
\$41 – and above=	6 trainees

Training Classifications

Preference shall be given to providing training in the following skilled work classifications. However, the classifications established are not all-inclusive:

Equipment Operators	Electricians
Laborers	Painters
Carpenters	Iron / Reinforcing Steel Workers
Concrete Finishers	Mechanics
Pipe Layers	Welders

The Department has on file common training classifications and their respective training requirements; that may be used by the contractors. Contractors shall submit new classifications for specific job functions that their employees are performing. The Department will review and recommend for acceptance the new classifications proposed by contractors, if applicable. New classifications shall meet the following requirements:

Proposed training classifications are reasonable and realistic based on the job skill classification needs, and the number of training hours specified in the training classification is consistent with common practices and provides enough time for the trainee to obtain journeyman level status.

Where feasible, 25% percent of apprentices or trainees in each occupation shall be in their first year of apprenticeship or training. The number of trainees shall be distributed among the work classifications on the basis of the contractor's needs and the availability of journeymen in the various classifications within a reasonable area of recruitment.

No employee shall be employed as a trainee in any classification in which they have successfully completed a training course leading to journeyman level status or in which they have been employed as a journeyman.

Records and Reports

The Contractor shall maintain enrollment in the program and submit all required reports documenting company compliance under these contract requirements. These documents and any other information shall be submitted to the OJT Program Coordinator as requested.

Upon the trainee's completion and graduation from the program, the Contractor shall provide each trainee with a certification Certificate showing the type and length of training satisfactorily completed.

Trainee Interviews

In order to determine the continued effectiveness of the OJT Program in Connecticut, the department will periodically conduct personal interviews with current trainees and may survey recent graduates of the program. This enables the OJT Program Coordinator to modify and improve the program as necessary. Trainee interviews are generally conducted at the job site to ensure that the trainees' work and training is consistent with the approved training program.

Trainee Wages

Contractors shall compensate trainees on a graduating pay scale based upon a percentage of the prevailing minimum journeyman wages (Davis-Bacon Act). Minimum pay shall be as follows:

60 percent	of the journeyman wage for the first half of the training period
75 percent	of the journeyman wage for the third quarter of the training period
90 percent	of the journeyman wage for the last quarter of the training period

In no case, will the trainee be paid less than the prevailing rate for general laborer as shown in the contract wage decision (must be approved by the Department of Labor).

Achieving or Failing to Meet Training Goals

The Contractor will be credited for each trainee currently enrolled or who becomes enrolled in the approved training program and providing they receive the required training under the specific training program. Trainees will be allowed to be transferred between projects if required by the Contractor's schedule and workload. The OJT Program Coordinator must be notified of transfers within five (5) days of the transfer or reassignments by e-mail (Phylisha.Coles@ct.gov).

Where a contractor does not or cannot achieve its annual training goal with female or minority trainees, they must produce adequate Good Faith Efforts documentation. Good Faith Efforts are those designed to achieve equal opportunity through positive, aggressive, and continuous result-oriented measures. 23 CFR § 230.409(g) (4). Contractors should request minorities and females from unions when minorities and females are under-represented in the contractor's workforce.

Whenever a contractor requests ConnDOT approval of someone other than a minority or female, the contractor must submit documented evidence of its Good Faith Efforts to fill that position with a minority or female. When a non-minority male is accepted, a contractor must continue to attempt to meet its remaining annual training goals with females and minorities.

Where a contractor has neither attained its goal nor submitted adequate Good Faith Efforts documentation, ConnDOT will issue a letter of non-compliance. Within thirty (30) days of receiving the letter of non-compliance, the contractor must submit a written Corrective Action Plan (CAP) outlining the steps that it will take to remedy the non-compliance. The CAP must be approved by ConnDOT. Failure to comply with the CAP may result in your firm being found non-responsive for future projects.

Measurement and Payment

Optional reimbursement will be made to the contractor for providing the required training under this special provision on ConnDOT Federal-Aid funded projects only.

Contractor will be reimbursed at \$0.80 for each hour of training given to an employee in accordance with an approved training or apprenticeship program. This reimbursement will be made even though the Contractor receives additional training program funds from other sources, provided such other source does not specifically prohibit the contractor from receiving other reimbursement.

Reimbursement for training is made annually or upon the trainees completion and not on a monthly basis. No payment shall be made to the Contractor if either the failure to provide the required training, or the failure to hire the trainee as a journeyman, is caused by the Contractor.

Program reimbursements will be made directly to the prime contractor on an annual basis. To request reimbursement, prime contractors must complete the Voucher for OJT Workforce Development Pilot Hourly Reimbursement for each trainee in the OJT Program. This form is included in the OJT Workforce Development Pilot package and is available on the Department's web site at:

www.ct.gov/dot

The completed form must be submitted to the Office of Contract Compliance for approval. The form is due on the 15th day of January for each trainee currently enrolled and for hours worked on ConnDOT Federal-Aid funded projects only.

D.B.E. SUBCONTRACTORS AND MATERIAL SUPPLIERS OR MANUFACTURERS

January 2013

I. ABBREVIATIONS AND DEFINITIONS AS USED IN THIS SPECIAL PROVISION

A. *CTDOT* means the Connecticut Department of Transportation.

B. *USDOT* means the U.S. Department of Transportation, including the Office of the Secretary, the Federal Highway Administration (“FHWA”), the Federal Transit Administration (“FTA”), and the Federal Aviation Administration (“FAA”).

C. *Broker* means a party acting as an agent for others in negotiating Contracts, Agreements, purchases, sales, etc., in return for a fee or commission.

D. *Contract, Agreement or Subcontract* means a legally binding relationship obligating a seller to furnish supplies or services (including but not limited to, construction and professional services) and the buyer to pay for them. For the purposes of this provision, a lease for equipment or products is also considered to be a Contract.

E. *Contractor* means a consultant, second party or any other entity under Contract to do business with CTDOT or, as the context may require, with another Contractor.

F. *Disadvantaged Business Enterprise (“DBE”)* means a for profit small business concern:

1. That is at least 51 percent owned by one or more individuals who are both socially and economically disadvantaged or, in the case of a corporation, in which 51 percent of the stock is owned by one or more such individuals; and
2. Whose management and daily business operations are controlled by one or more of the socially and economically disadvantaged individuals who own it; and
3. Certified by CTDOT under Title 49 of the Code of Federal Regulations, Part 26, (Title 49 CFR Part 23 of the Code of Federal Regulations for Participation of Disadvantaged Business Enterprise in Airport Concessions)

G. *USDOT-assisted Contract* means any Contract between CTDOT and a Contractor (at any tier) funded in whole or in part with USDOT financial assistance.

H. *Good Faith Efforts (“GFE”)* means all necessary and reasonable steps to achieve a DBE goal or other requirement which by their scope, intensity, and appropriateness to the objective, can reasonably be expected to fulfill the program requirement.

I. *Small Business Concern* means, with respect to firms seeking to participate as DBEs in USDOT-assisted Contracts, a small business concern as defined pursuant to Section 3 of the Small Business Act and Small Business Administration (“SBA”) regulations implementing it (13 CFR Part 121) that also does not exceed the cap on average annual gross receipts in 49 CFR Part 26, Section 26.65(b).

J. *Socially and Economically Disadvantaged Individual* means any individual who is a citizen (or lawfully admitted permanent resident) of the United States and who is:

1. Any individual who CTDOT finds, on a case-by-case basis, to be a socially and economically disadvantaged individual.
2. Any individuals in the following groups, members of which are rebuttably presumed to be socially and economically disadvantaged:
 - “Black Americans”, which includes persons having origins in any of the Black racial groups of Africa;
 - “Hispanic Americans”, which includes persons of Mexican, Puerto Rican, Cuban, Dominican, Central or South American, or other Spanish or Portuguese culture or origin, regardless of race;
 - “Native Americans”, which includes persons who are American Indians, Eskimos, Aleuts, or Native Hawaiians.
 - “Asian-Pacific Americans”, which includes persons whose origins are from Japan, China, Taiwan, Korea, Burma (Myanmar), Vietnam, Laos, Cambodia (Kampuchea), Thailand, Malaysia, Indonesia, the Philippines, Brunei, Samoa, Guam, the U.S. Trust Territories of the Pacific Islands (Republic of Palau), the Commonwealth of the Northern Marianas Islands, Macao, Fiji, Tonga, Kiribati, Juvalu, Nauru, or Federated States of Micronesia;
 - “Subcontinent Asian Americans”, which includes persons whose origins are from India, Pakistan, Bangladesh, Bhutan, the Maldives Islands, Nepal or Sri Lanka;
 - Women;
 - Any additional groups whose members are designated as socially and economically disadvantaged by the SBA, at such time as the SBA designation becomes effective.

K. *Commercially Useful Function (“CUF”)* means the DBE is responsible for the execution of the work of the contract and is carrying out its responsibilities by actually performing, managing, and supervising the work involved with its own forces and equipment. The DBE must be responsible for procuring, determining quantity, negotiating price, determining quality and paying for all materials (where applicable) associated with their work. The DBE must also perform at least 30% of the total cost of its contract with its own workforce.

II. ADMINISTRATIVE REQUIREMENTS

A. General Requirements

A DBE goal percentage equaling 13 percent (%) of the Contract value has been established for this Contract. This DBE goal percentage will be applied to the final Contract value to ultimately determine the required DBE goal. If additional work is required, DBE firms should be provided the appropriate opportunities to achieve the required DBE goal.

In order to receive credit toward the Contract DBE goal, the firms utilized as DBE subcontractors or suppliers must be certified as DBEs in the type of work to be counted for credit by CTDOT’s Office of Contract Compliance prior to the date of the execution of the subcontract. Neither CTDOT nor the State of Connecticut’s Unified Certification Program (UCP) makes any representation as to any DBE’s

technical or financial ability to perform the work. Prime contractors are solely responsible for performing due diligence in hiring DBE subcontractors.

All DBEs shall perform a CUF for the work that is assigned to them. The Contractor shall monitor and ensure that the DBE is in compliance with this requirement. The Connecticut DBE UPC Directory of certified firms can be found on the CTDOT website <http://www.ct.gov/dot>. The directory lists certified DBE firms with a description of services that they are certified to perform. Only work identified in this listing may be counted towards the project's DBE goal. A DBE firm may request to have services added at any time by contacting CTDOT's Office of Contract Compliance. No credit shall be counted for any DBE firm found not to be performing a CUF.

Once a Contract is awarded, all DBEs that were listed on the pre-award DBE commitment document must be utilized. The Contractor is obligated to provide the value and items of the work originally established in the pre-award documentation to the DBE firms listed in the pre-award documentation. Any modifications to the pre-award commitment must follow the procedure established in Section II-C.

The Contractor shall designate a liaison officer who will administer the Contractor's DBE program. Upon execution of this Contract, the name of the liaison officer shall be furnished in writing to CTDOT's unit administering the Contract, CTDOT's Office of Contract Compliance and CTDOT's Office of Construction ("OOC"). Contact information for the designated liaison officer shall be furnished no later than the scheduled date for the pre-construction meeting.

The Contractor shall submit a bi-monthly report to the appropriate CTDOT unit administering the Contract. This report shall indicate what work has been performed to date, with the dollars paid and percentage of DBE goal completed.

Verified payments made to DBEs shall be included in this bi-monthly report. A sample form is included on the CTDOT website.

In addition, the report shall include:

1. A projected time frame of when the remaining work is to be completed for each DBE.
2. A statement by the Contractor either confirming that the approved DBEs are on schedule to meet the Contract goal, or that the Contractor is actively pursuing a GFE.
3. If retainage is specified in the Contract specifications, then a statement of certification that the subcontractors' retainage is being released in accordance with 1.08.01 (Revised or supplemented).

Failure by the Contractor to provide the required reports may result in CTDOT withholding an amount equal to one percent (1%) of the monthly estimate until the required documentation is received.

The Contractor shall receive DBE credit when a DBE, or any combination of DBEs, perform work under the Contract in accordance with this specification.

Only work actually performed by and/or services provided by DBEs which are certified for such work and/or services, as verified by CTDOT, can be counted toward the DBE goal. Supplies and equipment a DBE purchases or leases from the Contractor or its affiliate cannot be counted toward the goal.

Monitoring of the CUF will occur by CTDOT throughout the life of the project. If it is unclear that the DBE is performing the work specified in its subcontract with the prime Contractor, further review may be required. If it is determined that the DBE is not performing a CUF, then the work performed by that DBE will not be counted towards the DBE goal percentage.

B. Subcontract Requirements

The Contractor shall submit to CTDOT's OOC all requests for subcontractor approvals on the standard CLA-12 forms provided by CTDOT. The dollar amount and items of work identified on the CLA-12 form must, at minimum, equal the dollar value submitted in the pre-award commitment. CLA-12 forms can be found at <http://www.ct.gov/dot/construction> under the "Subcontractor Approval" section. All DBE subcontractors must be identified on the CLA-12 form, regardless of whether they are being utilized to meet a Contract goal percentage. A copy of the legal Contract between the Contractor and the DBE subcontractor/supplier, a copy of the Title VI Contractor Assurances and a copy of the Required Contract Provision for Federal Aid Construction Contracts (Form FHWA-1273) (Federal Highway Administration projects only) must be submitted along with a request for subcontractor approval. These attachments cannot be substituted by reference.

If retainage is specified in the Contract specifications, then the subcontract agreement must contain a prompt payment mechanism that acts in accordance with Article 1.08.01 (Revised or supplemented).

If the Contract specifications do not contain a retainage clause, the Contractor shall not include a retainage clause in any subcontract agreement, and in this case, if a Contractor does include a retainage clause, it shall be deemed unenforceable.

In addition, the following documents are to be included with the CLA-12, if applicable:

- An explanation indicating who will purchase material.
- A statement explaining any method or arrangement for utilization of the Contractor's equipment.

The subcontract must show items of work to be performed, unit prices and, if a partial item, the work involved by all parties. If the subcontract items of work or unit prices are modified, the procedure established in Section II-C must be followed.

Should a DBE subcontractor further sublet items of work assigned to it, only lower tier subcontractors who are certified as a DBE firm will be counted toward the DBE goal. If the lower tier subcontractor is a non-DBE firm, the value of the work performed by that firm will not be counted as credit toward the DBE goal.

The use of joint checks between a DBE firm and the Contractor is acceptable, provided that written approval is received from the OOC prior to the issuance of any joint check. Should it become necessary to issue a joint check between the DBE firm and the Contractor to purchase materials, the DBE firm must be responsible for negotiating the cost, determining the quality and quantity, ordering the material and installing (where applicable), and administering the payment to the supplier. The Contractor should not make payment directly to suppliers.

Each subcontract the Contractor signs with a subcontractor must contain the following assurance:

“The subcontractor/supplier/manufacture shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of DOT-assisted contracts. Failure by the contractor/subcontractor/supplier/manufacture to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the recipient deems appropriate.”

C. Modification to Pre-Award Commitment

Contractors may not terminate for convenience any DBE subcontractor or supplier that was listed on the pre-award DBE commitment without prior written approval of the OOC. This includes, but is not limited to, instances in which a Contractor seeks to perform work originally designated for a DBE subcontractor with its own forces or those of an affiliate, a non-DBE firm, or with another DBE firm. Prior to approval, the Contractor must demonstrate to the satisfaction of the OOC, that it has good cause, as found in 49CFR Part 26.53 (f)(3), for termination of the DBE firm.

Before transmitting its request for approval to terminate pre-award DBE firms to the OOC, the Contractor must give written notice to the DBE subcontractor and include a copy to the OOC of its notice to terminate and/or substitute, and the reason for the notice.

The Contractor must provide five (5) days for the affected DBE firm to respond. This affords the DBE firm the opportunity to advise the OOC and the Contractor of any reasons why it objects to the termination of its subcontract and why the OOC should not approve the Contractor’s action.

Once the Contract is awarded, should there be any amendments or modifications of the approved pre-award DBE submission other than termination of a DBE firm, the Contractor shall follow the procedure below that best meets the criteria associated with the reason for modification:

1. If the change is due to a scope of work revision or non-routine quantity revision by CTDOT, the Contractor must notify CTDOT’s OOC in writing or via electronic mail that their DBE participation on the project may be impacted as soon as they are aware of the change. In this case, a release of work from the DBE firm may not be required; however the Contractor must concurrently notify the DBE firm in writing, and copy the OOC for inclusion in the project DBE file. This does not relieve the Contractor of its obligation to meet the Contract specified DBE goal, or of any other responsibility found in this specification.
2. If the change is due to a factor other than a CTDOT directive, a request for approval in writing or via electronic mail of the modification from the OOC must be submitted, along with an explanation of the change(s), prior to the commencement of work. The Contractor must also obtain a letter of release from the originally named DBE indicating their concurrence with the change, and the reason(s) for their inability to perform the work. In the event a release cannot be obtained, the Contractor must document all efforts made to obtain it.
3. In the event a DBE firm that was listed in the pre-award documents is **unable** or **unwilling** to perform the work assigned, the Contractor shall:

- Notify the OOC Division Chief immediately and make efforts to obtain a release of work from the firm.
- Submit documentation that will provide a basis for the change to the OOC for review and approval prior to the implementation of the change.
- Use the DBE Directory to identify and contact firms certified to perform the type of work that was assigned to the unable or unwilling DBE firm. The Contractor should also contact CTDOT's Office of Contract Compliance for assistance in locating additional DBE firms to the extent needed to meet the contract goal.

Should a DBE subcontractor be terminated or fail to complete work on the Contract for any reason, the Contractor must make a GFE to find another DBE subcontractor to substitute for the original DBE. The DBE replacement shall be given every opportunity to perform at least the same amount of work under the Contract as the original DBE subcontractor.

If the Contractor is unable to find a DBE replacement:

- The Contractor should identify other contracting opportunities and solicit DBE firms in an effort to meet the Contract DBE goal requirement, if necessary, and provide documentation to support a GFE. (Refer to GFE in Section III.)
- The Contractor must demonstrate that the originally named DBE, who is unable or unwilling to perform the work assigned, is in default of its subcontract, or identify other issues that affected the DBE firm's ability to perform the assigned work. **The Contractor's ability to negotiate a more advantageous agreement with another subcontractor is not a valid basis for change.**

III. GOOD FAITH EFFORTS

The DBE goal is **NOT** reduced or waived for projects where the Contractor receives a Pre-Award GFE determination from the Office of Contract Compliance prior to the award of the Contract. It remains the responsibility of the Contractor to make a continuing GFE to achieve the specified Contract DBE goal. The Contractor shall pursue every available opportunity to obtain additional DBE firms and document all efforts made in such attempts.

At the completion of all Contract work, the Contractor shall submit a final report to CTDOT's unit administering the Contract indicating the work done by and the dollars paid to DBEs. Only verified payments made to DBEs performing a CUF will be counted towards the Contract goal.

Goal attainment is based on the total Contract value, which includes all construction orders created during the Contract. If the Contractor does not achieve the specified Contract goal for DBE participation or has not provided the value of work to the DBE firms originally committed to in the pre-award submission, the Contractor shall submit documentation to CTDOT's unit administering the Contract detailing the GFE made during the performance of the Contract to satisfy the goal.

A GFE should consist of the following, where applicable (CTDOT reserves the right to request additional information):

1. A detailed statement of the efforts made to replace an unable or unwilling DBE firm, and a description of any additional subcontracting opportunities that were identified and offered to DBE firms in order to increase the likelihood of achieving the stated goal.
2. A detailed statement, including documentation of the efforts made to contact and solicit bids from certified DBEs, including the names, addresses, and telephone numbers of each DBE firm contacted; the date of contact and a description of the information provided to each DBE regarding the scope of services and anticipated time schedule of work items proposed to be subcontracted and the response from firms contacted.
3. Provide a detailed explanation for each DBE that submitted a subcontract proposal which the Contractor considered to be unacceptable stating the reason(s) for this conclusion.
4. Provide documentation, if any, to support contacts made with CTDOT requesting assistance in satisfying the specified Contract goal.
5. Provide documentation of all other efforts undertaken by the Contractor to meet the defined goal. Additional documentation of efforts made to obtain DBE firms may include but will not be limited to:
 - Negotiations held in good faith with interested DBE firms, not rejecting them without sound reasons.
 - Written notice provided to a reasonable number of specific DBE firms in sufficient time to allow effective participation.
 - Those portions of work that could be performed by readily available DBE firms.

In instances where the Contractor can adequately document or substantiate its GFE and compliance with other DBE Program requirements, the Contractor will have satisfied the DBE requirement and no administrative remedies will be imposed.

IV. PROJECT COMPLETION

At the completion of all Contract work, the Contractor shall:

1. Submit a final report to CTDOT's unit administering the Contract indicating the work done by, and the dollars paid to DBEs.
2. Submit verified payments made to all DBE subcontractors for the work that was completed.
3. Submit documentation detailing any changes to the DBE pre-award subcontractors that have not met the original DBE pre-award commitment, including copies of the Department's approvals of those changes.
4. Retain all records for a period of three (3) years following acceptance by CTDOT of the Contract and those records shall be available at reasonable times and places for inspection by authorized representatives of CTDOT and Federal agencies. If any litigation, claim, or audit is started before

the expiration of the three (3) year period, the records shall be retained until all litigation, claims, or audit findings involving the records are resolved.

If the Contractor does not achieve the specified Contract goal for DBE participation in addition to meeting the dollar value committed to the DBE subcontractors identified in the pre-award commitment, the Contractor shall submit documentation to CTDOT's unit administering the Contract detailing the GFE made during the performance of the Contract to satisfy the goal.

V. SHORTFALLS

A. Failure to meet DBE goals

As specified in (II-A) above, attainment of the Contract DBE goal is based on the final Contract value. The Contractor is expected to achieve the amount of DBE participation originally committed to at the time of award; however, additional efforts must be made to provide opportunities to DBE firms in the event a Contract's original value is increased during the life of the Contract.

The Contractor is expected to utilize the DBE subcontractors originally committed in the DBE pre-award documentation for the work and dollar value that was originally assigned.

If a DBE is terminated or is unable or unwilling to complete its work on a Contract, the Contractor shall make a GFE to replace that DBE with another certified DBE to meet the Contract goal.

The Contractor shall immediately notify the OOC of the DBE's inability or unwillingness to perform, and provide reasonable documentation and make efforts to obtain a release of work from the firm.

If the Contractor is unable to find a DBE replacement, then the Contractor should identify other contracting opportunities and solicit DBE firms in an effort to meet the Contract DBE goal requirement, if necessary, and provide documentation to support a GFE.

When a DBE is unable or unwilling to perform, or is terminated for just cause, the Contractor shall make a GFE to find other DBE opportunities to increase DBE participation to the extent necessary to at least satisfy the Contract goal.

For any DBE pre-award subcontractor that has been released appropriately from the project, no remedy will be assessed, provided that the Contractor has met the criteria described in Section II-C.

B. Administrative Remedies for Non-Compliance:

In cases where the Contractor has failed to meet the Contract specified DBE goal or the DBE pre-award commitment, and where no GFE has been demonstrated, then one or more of the following administrative remedies will be applied:

1. A reduction in Contract payments to the Contractor as determined by CTDOT, not to exceed the shortfall amount of the **DBE goal**. The maximum shortfall will be calculated by multiplying the

Contract DBE goal (adjusted by any applicable GFE) by the final Contract value, and subtracting any verified final payments made to DBE firms by the Contractor.

2. A reduction in Contract payments to the Contractor determined by CTDOT, not to exceed the shortfall amount of the **pre-award commitment**. The maximum shortfall will be calculated by subtracting any verified final payments made by the Contractor to each DBE subcontractor from the amount originally committed to that subcontractor in the pre-award commitment.
3. A reduction in Contract payments to the Contractor determined by CTDOT for any pre-award DBE subcontractor who has not obtained the dollar value of work identified in the DBE pre-award commitment and has not followed the requirements of Section II-C or for any DBE firm submitted for DBE credit that has not performed a CUF.
4. The Contractor being required to submit a written DBE Program Corrective Action Plan to CTDOT for review and approval, which is aimed at ensuring compliance on future projects.
5. The Contractor being required to attend a Non-Responsibility Meeting on the next contract where it is the apparent low bidder.
6. The Contractor being suspended from bidding on contracts for a period not to exceed six (6) months.

VI. CLASSIFICATIONS OTHER THAN SUBCONTRACTORS

A. Material Manufacturers

Credit for DBE manufacturers is 100% of the value of the manufactured product. A manufacturer is a firm that operates or maintains a factory or establishment that produces on the premises the materials or supplies obtained by the Contractor.

If the Contractor elects to utilize a DBE manufacturer to satisfy a portion of, or the entire specified DBE goal, the Contractor must provide the OOC with:

- Subcontractor Approval Form (CLA-12) indicating the firm designation,
- An executed "Affidavit for the Utilization of Material Suppliers or Manufacturers" (sample attached), and
- Substantiation of payments made to the supplier or manufacturer for materials used on the project.

B. Material Suppliers (Dealers)

Credit for DBE dealers/suppliers is limited to 60% of the value of the material to be supplied, provided such material is obtained from an approved DBE dealer/supplier.

In order for a firm to be considered a regular dealer, the firm must own, operate, or maintain a store, warehouse, or other establishment in which the materials, supplies, articles or equipment of the general character described by the specifications and required under the contract are bought, kept in stock, and regularly sold or leased to the public in the usual course of business. At least one of the following criteria

must apply:

- To be a regular dealer, the firm must be an established, regular business that engages, as its principal business and under its own name, in the purchase and sale or lease of the products in question.
- A person may be a regular dealer in such bulk items as petroleum products, steel, cement, gravel, stone, or asphalt without owning, operating or maintaining a place of business if the person both owns and operates distribution equipment for the products. Any supplementing of the regular dealers' own distribution equipment shall be by long term lease agreement, and not on an ad hoc or contract to contract basis.
- Packers, brokers, manufacturers' representatives, or other persons who arrange or expedite transactions are not regular dealers within the meaning of this paragraph.

If the Contractor elects to utilize a DBE supplier to satisfy a portion or the entire specified DBE goal, the Contractor must provide the OOC with:

- Subcontractor Approval Form (CLA-12) indicating the firm designation,
- An executed "Affidavit for the Utilization of Material Suppliers or Manufacturers" (sample attached), and
- Substantiation of payments made to the supplier or manufacturer for materials used on the project.

C. Brokering

- Brokering of work for DBE firms who have been listed by the Department as certified brokers is allowed. Credit for those firms shall be applied following the procedures in Section VI-D.
- Brokering of work by DBEs who have been approved to perform subcontract work with their own workforce and equipment is not allowed, and is a Contract violation.
- Firms involved in the brokering of work, whether they are DBEs and/or majority firms who engage in willful falsification, distortion or misrepresentation with respect to any facts related to the project shall be referred to the U.S. DOT, Office of the Inspector General for prosecution under Title 18, U.S. Code, Part I, Chapter 47, Section 1020.

D. Non-Manufacturing or Non-Supplier DBE Credit

Contractors may count towards their DBE goals the following expenditures with DBEs that are not manufacturers or suppliers:

- Reasonable fees or commissions charged for providing a bona fide service such as professional, technical, consultant or managerial services and assistance in the procurement of essential personnel, facilities, equipment materials or supplies necessary for the performance of the Contract, provided that the fee or commission is determined by the OOC to be reasonable and consistent with fees customarily allowed for similar services.
- The fees charged only for delivery of materials and supplies required on a job site when the hauler, trucker, or delivery service is a DBE, and not the manufacturer, or regular dealer of the materials and

supplies, and provided that the fees are determined by the OOC to be reasonable and not excessive as compared with fees customarily allowed for similar services.

- The fees or commissions charged for providing bonds or insurance specifically required for the performance of the Contract, provided that the fees or commissions are determined by CTDOT to be reasonable and not excessive as compared with fees customarily allowed for similar services.

E. Trucking

While technically still considered a subcontractor, the rules for counting credit for DBE trucking firms are as follows:

- The DBE must own and operate at least one fully licensed, insured, and operational truck used on the Contract.
- The DBE receives credit for the total value of the transportation services it provides on the Contract using trucks it owns, insures and operates using drivers it employs.
- The DBE may lease trucks from another DBE firm, including an owner-operator who is certified as a DBE. The DBE who leases trucks from another DBE receives credit for the total value of the transportation services the lessee DBE provides on the Contract.
- The DBE may lease trucks from a non-DBE firm; however the DBE may only receive credit for any fees or commissions received for arranging transportation services provided by the non-DBE firms. Additionally, the DBE firm must demonstrate that they are in full control of the trucking operation for which they are seeking credit.

VII. Suspected DBE Fraud

In appropriate cases, CTDOT will bring to the attention of the USDOT any appearance of false, fraudulent, or dishonest conduct in connection with the DBE program, so that USDOT can take the steps, e.g. referral to the Department of Justice for criminal prosecution, referral to USDOT Inspector General, action under suspension and debarment or Program Fraud and Civil Penalties rules provided in 49 CFR Part 31.

**CONNECTICUT DEPARTMENT OF TRANSPORTATION
(OFFICE OF CONSTRUCTION)
BUREAU OF ENGINEERING AND CONSTRUCTION**

This affidavit must be completed by the State Contractor's DBE notarized and attached to the contractor's request to utilize a DBE supplier or manufacturer as a credit towards its DBE contract requirements; failure to do so will result in not receiving credit towards the contract DBE requirement.

State Contract No.

Federal Aid Project No.

Description of Project

I, _____, acting in behalf of _____,
(Name of person signing Affidavit) (DBE person, firm, association or corporation)
of which I am the _____ certify and affirm that _____
(Title of Person) (DBE person, firm, association or corporation)

is a certified Connecticut Department of Transportation DBE. I further certify and affirm that I have read and understand 49 CFR, Sec. 26.55(e)(2), as the same may be revised.

I further certify and affirm that _____ will assume the actual and
(DBE person, firm, association or Corporation)
for the provision of the materials and/or supplies sought by _____.

If a manufacturer, I operate or maintain a factory or establishment that produces, on the premises, the materials, supplies, articles or equipment required under the contract an of the general character described by the specifications.

If a supplier, I perform a commercially useful function in the supply process. As a regular dealer, I, at a minimum, own and operate the distribution equipment for bulk items. Any supplementing of my distribution equipment shall be by long-term lease agreement, and not on an ad hoc or contract-by-contract basis.

I understand that false statements made herein are punishable by Law (Sec. 53a-157), CGS, as revised).

(Name of Corporation or Firm)

(Signature & Title of Official making the Affidavit)

Subscribed and sworn to before me, this _____ day of _____ 20 _____.

Notary Public (Commissioner of the Superior Court)

My Commission Expires _____

CERTIFICATE OF CORPORATION

I, _____, certify that I am the _____
(Official) (President)

of the Corporation named in the foregoing instrument; that I have been duly authorized to affix the seal of the Corporation to such papers as require the seal; that _____, who signed said instrument on behalf of the Corporation, was then of said corporation; that said instrument was duly signed for and in behalf of said Corporation by authority of its governing body and is within the scope of its corporation powers.

(Signature of Person Certifying)

(Date)

ITEM #0000191A - NON-DESTRUCTIVE UTILITY INVESTIGATION
(ESTIMATED COST)

Description: This item shall consist of investigating and locating utilities using non-destructive methods, using the services of a professional utility locating company in accordance with this specification, within construction limits shown on the plans or as directed by the Engineer. This item shall include the field survey/location, field paint/stake marking, and color marking on plans. All utility investigation locations and services shall be preapproved by the Engineer.

Materials: The Contractor shall provide all necessary equipment and materials needed to identify underground utilities through the use of non-destructive methods such as ground penetrating radar, magnetic or electrical detectors, and other such scanning methods.

Construction Methods:

- 1. General:** The locations of utilities present shall first be reviewed on the plans and in the field, reconciling all surface evidence of utilities (such as gate valves, manholes, handholes, etc.) with what is depicted on the plans. The professional utility location company shall use this information to conduct the non-destructive locating, using the method appropriate to the utility being investigated. Types of utilities which will require locating shall include, but not be limited to gas lines, water lines sewer lines, drainage lines, electrical conduits/wires/cables/duct banks and fiber optic cables, including related structures like valves, handholes and manholes.
- 2. Marking and Labelling:** All located utilities shall be tagged, marked, or labeled in the field using standard industrial/engineering/construction methods such as spray paint, stakes, vertical markers, labels, ribbons identification tapes, etc.
- 3. Marking Plans:** All located utilities shall be marked on plans. The colors, patterns and/or symbols shall comply with current industrial/engineering/construction design standards. A copy of the plans showing the located utilities shall be provided to the Engineer.
- 4. Site Access:** This work will be performed within ConnDOT-owned facilities. These facilities may often need to remain in operation during the investigation. Many of these sites are restricted in access due to security concerns. The Contractor must coordinate the professional utility locating subcontractor's activities and access with the Engineer.

Method of Measurement: Utility investigation will not be measured for payment. The extent of the utility investigation required shall be as depicted on the plans or as directed by the Engineer.

Basis of Payment: The sum of money shown on the estimate and in the itemized proposal as "Estimated Cost" for this work will be considered the bid price even though payment will be made as described below. The estimated cost figure is not to be altered in any manner by the bidder. Should the bidder alter the amount shown, the altered figures will be disregarded and the original price will be used to determine the total amount for the contract.

“Non-Destructive Utility Investigation (Estimated Cost)” will be paid for at the actual rate charged for the utility investigation services (receipted bills) by the entity which actually provided the services which have been approved by the Engineer plus a five-percent (5%) markup.

<u>Pay Item</u>	<u>Pay Unit</u>
Non-Destructive Utility Investigation (Estimated Cost)	est.

ITEM #0101019A - INDOOR AIR QUALITY MANAGEMENT PLAN

Description:

Work under this item shall include the development of an Indoor Air Quality Construction/Management Plan and implementation of indoor air quality (IAQ) control measures during project construction in order to sustain the comfort and well-being of both construction workers and building occupants. IAQ control measures include, but are not limited to, protecting HVAC equipment/ductwork, use of low volatile organic compounds (VOC's) materials, protection of materials and spaces from moisture intrusion and microbial growth and limiting transmission of dust from construction areas to occupied building areas.

All IAQ work activities shall be performed in compliance with regulatory requirements including, but not limited to, the current applicable revision of the OSHA General Duty Clause 29 CFR 1910 Section 5(a)(1), OSHA Respiratory Protection Standard 29 CFR 1910.134, OSHA Construction Standards 29 CFR 1926 and in general accordance with applicable Industry Standards and Guidelines on Indoor Air Quality, such as; *IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition, Chapter 3, November 2007*, The Sheet Metal and Air Conditioner Contractors National Association (SMACNA); U.S. Green Building Council (USGBC) – *Leadership in Energy and Environmental Design (LEED) 2009 for New Construction and Major Renovations*, ASHRAE Standard 55 *Thermal Environmental Conditions for Human Occupancy*, ASHRAE Standard 62.1 *Ventilation for Acceptable Indoor Air Quality* and the State of Connecticut Office of Policy Management (OPM) Establishment of High Performance Building Construction Standards (HPBCS) for State Funded Buildings (16a-38k-1 through 7).

Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

1. Provide an Indoor Air Quality Construction/Management Plan based upon SMACNA and USGBC LEED guidelines that includes IAQ control measures to be instituted onsite such as HVAC protection, source control, pathway interruption/engineering controls, work practices/housekeeping, and scheduling/phasing. Such plan shall be prepared and signed by a Certified Industrial Hygienist (CIH).
2. Include a list of proposed indoor construction and finishing products for materials such as paints, coatings, caulks, sealants, adhesives, carpeting, laminates, cleaning agents, etc. and provide IAQ Product Data/Safety Data Sheets regarding VOC content.
3. Name and qualifications of the Contractor's Project Superintendent or other individual responsible for ensuring the complete implementation of the Indoor Air Quality Construction Plan. Such individual shall have the authority to implement changes to work practices, add controls, or stop work as necessary to fully implement the intent of this item.
4. Project time schedule for each phase of work.

No construction activities shall commence until the submittals listed above have been received and accepted by the Engineer.

Deviations from these Specifications require the written approval of the Engineer.

Materials:

All materials shall be delivered to the job site in the original packages, containers, or bundles bearing the name of the manufacturer, the brand name and product technical description.

Materials shall be stored and used consistent with manufacturer's recommendations and in a manner to prevent moisture impact.

Where applicable, materials shall be low VOC/low odor containing/emitting materials.

Construction Methods:

(1) Indoor Air Quality Management Provisions:

The Contractor shall implement IAQ management provisions, as outlined in the submitted IAQ Construction/Management Plan, and including as applicable/necessary those provisions detailed below, in a manner to maintain acceptable IAQ conditions.

(a) HVAC Protection

The Contractor shall shut down HVAC systems that are serving only construction areas and all duct equipment openings will be sealed off with plastic to prevent the accumulations of dust and debris in the duct system.

In the event that the HVAC system must be in operation in order to serve occupied areas, provide Minimum Efficiency Reporting Value (MERV) 8 filters for supply air intakes and/or air handler units and at the return system openings. Replace all filtration media immediately prior to occupancy.

Perform frequent maintenance when the HVAC system is being used and replace filters as needed.

For construction activities that produce dust such as, but not limited to, drywall sanding, concrete cutting, masonry work, wood sawing, or adding insulation, seal off all supply diffusers and return air system openings completely for the duration of the task.

The Contractor shall not store construction or waste materials in mechanical room where HVAC units are present.

(b) Source Control

The Contractor shall use low VOC, low odor and low emitting products/materials, typically meeting the USGBC LEED and/or CT HPBCS VOC content guidelines, particularly for paints, carpet, composite board, adhesives and sealants that have the potential for significant emissions. All containers for paints, adhesives and sealants will be stored in a separate secure location at all times when not in use. During construction all lids on containers of wet products shall be closed as much as possible.

Exhaust pollution sources to the outside with portable fan systems. Prevent exhaust from recirculating back into the building.

As necessary, provide air filtering devices such as high efficiency particular air (HEPA) filters or activated carbon filters to capture/control airborne contaminants at their source.

Protect stored on-site or installed absorptive building materials from weather and moisture.

(c) Pathway Interruption/Engineering Controls

The Contractor shall provide dust curtains, poly critical barriers, temporary enclosures or other engineering controls to prevent dust from migrating outside the construction area.

Of special concern is the prevention of any dust/debris/etc. contaminants into kitchens/food prep/storage and cafeteria areas.

Weather permitting, areas with contaminated air shall be ventilated with 100% outside air and the contaminated air will be directly filtered/exhausted to the outside.

Contractor shall identify and mark major indoor construction walkways and pathways for the project and protect adjacent spaces from contaminant migration.

(d) Work Practices/Housekeeping

The entrances to construction areas shall have temporary walk-off mats to collect particulate.

Dust collection/filtration attachments will be used on power tool equipment such as saws, sanders, grinders, etc. that generate dust particles.

Suppress dust generation with wetting agents or sweeping compounds. Clean up dust using wet rags or damp mop. Vacuums used for housekeeping activities shall have high efficiency particulate air (HEPA) filters. Increase cleaning frequency when dust build-up is noted.

Provide temporary ventilation/filtration during construction to minimize accumulation of dust, fumes, odors, vapors and gases in the building.

Remove spills or excess applications of solvent-containing materials as soon as possible.

All HVAC coils, air filters, fans and ductwork shall remain as clean as possible during construction and shall be cleaned before the testing and balancing of the HVAC system.

(e) Scheduling

The Contractor shall comply with manufacturer's instructions for appropriate drying times.

Where odorous and VOC emitting products are applied on-site, apply them before installation of porous and fibrous materials.

Ensure spaces are weather tight and protected from moisture intrusion prior to installation of porous/absorptive materials such as ceiling tiles, carpet, drywall.

Ensure that wet applied interior finish materials such as paints, adhesives, sealants, coatings, finishes are properly and fully cured before installing other finish material over them. Install carpets and furnishings after all other interior finish materials have been applied and fully cured. Complete installation of interior finishing materials and continuously flush out building for as long as necessary to achieve Indoor Air Quality levels listed below or as alternatively approved by the Engineer. Levels must be achieved prior to the Contractor progressing to the next work phase as defined on the Phasing Plans in the Contract. Such levels must be maintained continuously when working in occupied spaces. Contractor must also complete work in such a way so as not to exceed Indoor Air Quality levels beyond current work area.

(f) Personnel Protection

The Contractor shall use all appropriate engineering controls and safety and protective equipment while performing the work in accordance with applicable standards and guidelines.

The Contractor shall be responsible for the health and safety protection of its own employees. Respiratory protection shall be provided, as necessary, and shall meet the requirements of OSHA as required in 29 CFR 1910.134. A formal respiratory protection program must be implemented in accordance with 29 CFR 1910.134 if respiratory protection is being used. The Contractor shall provide respirators from among those approved as being acceptable for protection by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 30 CFR Part II.

All other necessary personnel protective equipment (i.e. hardhat, work boots, safety glasses, hearing protection, etc.) required to perform the IAQ activities shall conform to all applicable federal, state and local regulations.

All other persons entering Construction Areas shall adhere to the requirements of personnel protection as stated in this section.

(g) Quality Assurance/Verification

At a minimum, after completion of work, the construction areas shall be free of visible dust/debris, mold/moisture and odors.

The Engineer’s on-site Project Monitor will verify compliance with these specifications, conduct construction work area inspections, IAQ testing via direct read instrumentation or collecting samples, photographs, and/or videos of the cleaned surfaces/work areas as deemed necessary to ensure compliance with ASHRAE Standards 55 & 62, CT OPM HPBCS and the USGBC LEED Indoor Environmental Quality Guidelines, including the IAQ parameters listed below.

Contaminant:	CO	CO₂	PM₁₀	TVOC	RH	T
Guideline:	9 ppm & <2ppm above ambient	<700ppm above ambient	50 ug/m ³	500 ug/m ³	<60%	Winter 68-79F Sumer 74-78F

(2) Project Closeout Data:

The Contractor’s Project Superintendent shall keep a logbook to document daily site activity. The log book shall document the preparation tasks, schedule, engineering controls utilized, daily lists of employees on site, PPE utilized and IAQ control measures instituted during construction activities.

The Contractor will submit the original log book and any other related documentation to the Engineer within 30 days of completion of work.

Final payment to the Contractor will not be approved without submission of the closeout data.

Method of Measurement:

No measurement will be made for the work in this Section. The completed work shall be paid as a lump sum.

Basis of Payment:

The lump sum bid price for this item shall include the specialty services of the Contractor for IAQ management including: labor, materials, equipment, insurance, submittals, personal protection equipment, temporary enclosures, engineering controls, work practices, housekeeping, utility costs, incidentals, fees and close out documentation.

Final payment for Indoor Air Quality Management will not be made until all project closeout data submittals have been completed and provided to the Engineer. Once the completed package has been received in its entirety, the Engineer will make the final payment to the Contractor.

<u>Pay Item</u>	<u>Pay Unit</u>
Indoor Air Quality Management Plan	Lump Sum

ITEM #0101143A - HANDLING AND DISPOSAL OF REGULATED ITEMS

Description:

Work under this item shall include the management (handling and disposal) of regulated items and all associated work by persons who are employed by a CTDEEP permitted Spill Contractor and trained/certified in accordance with OSHA Hazard Communication regulations. Regulated items include hazardous and other materials and wastes, the disposal of which is restricted by Federal and/or State laws and regulations, and which may be a component of equipment or other items located on-site. Regulated items include those listed herein, or additional similar items identified on site by the Engineer. Work under this item does not include asbestos containing materials, lead paint, contaminated or hazardous soils.

Activities shall be performed in accordance with, but not limited to, the current revision of the USEPA & CTDEEP Hazardous Waste Regulations (40 CFR 260-282, 22a-209 and 22a-449(c)), USEPA PCB Regulations (40 CFR 761), USEPA Protection of Stratospheric Ozone (40 CFR 82), OSHA Hazard Communication (29 CFR 1910.1200), OSHA Hazardous Waste & Emergency Response Regulations (29 CFR 1910.120), USDOT Hazardous Materials Regulation (49 CFR 171-180), OSHA, RCRA, CERCLA, CAA, TSCA, and all other laws and regulations.

The work activities include the removal, handling, packing, labeling, transport, manifesting, and recycling or disposal of various regulated items at the Project site prior to beginning planned demolition activities.

The Contractor is solely responsible for verifying actual locations and quantities of the items with hazardous/regulated material/waste constituents and for their proper handling and disposal. The recycling or proper disposal, as appropriate, of all regulated items shall be completed prior to the initiation of any demolition activities.

Materials:

All materials shall be suitable for the management of regulated items and shall meet all applicable federal, state and local regulations. Such materials include, but are not limited to, proper containers, packing materials, labels, signs, shipping papers, personnel protective equipment (PPE) and spill kits.

Construction Methods:

(1) Allowable Disposal/Recycling Facilities

Disposal facilities for RCRA-hazardous, TSCA-hazardous, Connecticut Regulated, and Universal wastes shall be chosen from among those listed below. No other facility shall be used for these types of wastes without the written approval of the Engineer.

Advanced Disposal Services
Greentree Landfill
635 Toby Road
Kersey, PA 15846
Phone: (814) 265-1744 Fax: (814) 265-8745
MSW, C&D, asbestos, PCB remediation waste <50
ppm, petroleum contaminated soils, nonhazardous solid
wastes

Advanced Disposal
(managed by Interstate Waste Services)
7095 Glades Pike
Summerset, PA 15501
Phone: (814) 444-0112 Fax: (814) 444-0127
MSW, C&D debris, residual waste, sewer sludge,
incinerator ash, asbestos

Allied Waste Niagara Falls Landfill, LLC
5600 Niagara Falls Blvd.
Niagara, NY 14304
Phone: (716) 285-3344 Fax: (716) 285-3398
Non-hazardous waste, industrial solid waste, municipal
sewage treatment sludge, contaminated soil & debris,
asbestos waste, C&D debris, industrial process sludge

American Lamp Recycling, LLC
26 Industrial Way
Wappingers Falls, NY 12590
Phone: (845) 896-0058 Fax: (845) 896-1520
Mercury containing device, universal waste

Tradebe (Bridgeport United Recycling, Inc.)
50 Cross Street
Bridgeport, CT 06610
Phone: (203) 334-1666 Fax: (203) 334-1439
RCRA & CRW waste oil, fuel, wastewater

Clean Earth of Carteret
24 Middlesex Ave.,
Carteret, NJ 07008
Phone: (732) 541-8909 Fax: (732) 541-8505
Concrete, brick, block, street sweepings, stone, rock,
asphalt and petroleum contaminated soil

Clean Earth of Philadelphia, Inc.
3201 South 61 St.,
Philadelphia, PA 19153
Phone: (215) 724-5520 Fax: (215) 724-2939
Petroleum contaminated soil

Clean Earth of North Jersey, Inc. (aka CENJ)
115 Jacobus Ave,
South Kearny, NJ 07105
Phone: (973) 344-4004 Fax: (973) 344-8652
RCRA liquid and solid, asbestos

Clean Earth of Southeast Pennsylvania, Inc.
7 Steel Road,
Morrisville, PA 19067
Phone: (215) 428-1700 Fax: (215) 428-1704
Petroleum contaminated soil

Clean Harbors Environmental Services, Inc.
2247 South Hwy. 71,
Kimball, NE 69145
Phone: (308) 235-1012 Fax: (308) 235-4307
RCRA liquid, solid & sludge

Clean Harbors Environmental Services, Inc.
Cleveland Facility
2900 Rockefeller Ave.,
Cleveland, OH 44115
Phone: (216) 429-2401 Fax: (216) 883-1918
RCRA liquid: aqueous organic & inorganic wastewater

Clean Harbors Environmental Services, Inc.
Spring Grove Facility
4879 Spring Grove Ave.,
Cincinnati, OH 45232
Phone: (513) 681-6242 Fax: (513) 681-0869
RCRA liquid, solid & sludge: aqueous organic &
inorganic wastewater, PCB wastewater treatment

Clean Harbors of Baltimore, Inc.
1910 Russell St,
Baltimore, MD 21230
Phone: (410) 244-8200 Fax: (410) 752-2647
RCRA liquid: aqueous organic & inorganic wastewater

Clean Harbors of Braintree, Inc.
1 Hill Avenue,
Braintree, MA 02184
Phone: (781) 380-7134 Fax: (781) 380-7193
RCRA & TSCA liquid & solid

Clean Harbors of Connecticut, Inc.
51 Broderick Road,
Bristol, CT 06010
Phone: (860) 583-8917 Fax: (860) 583-1740
RCRA & CRW liquid

Clean Harbors of Woburn
(Murphy's Waste Oil Services, Inc.)
252 Salem Street,
Woburn, MA 01801
Phone: (781) 935-9066 Fax: (781) 935-8615
RCRA liquid: oil, oil/water mixtures; CRW oil filters,
oily soil & debris, F001/F002 contaminated oils,
antifreeze

Clinton Landfill
242 Church Street
Clinton, MA 01510
Phone: (978) 365-4110 Fax: (978) 365-4106
Comm-97 soils and other materials subject to a BUD
and additional review by MADEP (*2-week lead time
for review by MADEP)

Colonie Landfill (Waste Connections, Inc.)
1319 Loudon Rd,
Cohoes, New York 12047
Phone: (518) 783-2827 Fax: (518) 786-7331
Non-haz. wastes, special wastes, contaminated soil

Cumberland County Landfill
(aka Community Refuse Services
Managed by Interstate Waste Services)
135 Vaughn Road,
Shippensburg, PA 17257
Phone: (717) 729-2060 Fax: (717) 423-6822
Municipal solid waste, non-hazardous waste

ACV Enviro (aka Cycle Chem & General
Chemical Corp.)
217 South First Street,
Elizabeth, NJ 07206
Phone: (908) 355-5800 Fax: (908) 355-0562
RCRA, TSCA liquid and solid

Envirite of PA (US Ecology)
730 Vogelsong Road,
York, PA 17404
Phone: (717) 846-1900 Fax: (717) 854-6757
RCRA hazardous wastes

Environmental Quality Company:
Wayne Disposal Facility
(aka EQ Michigan Disposal Waste Treatment Plant
and Wayne Disposal Inc. Site #2)
49350 North I-94 Service Drive
Belleville, MI 48111
Phone: (734) 697-2200 Fax: (734) 699-3499
RCRA & TSCA liquid and solid

US Ecology (Environmental Quality Detroit Inc.)
1923 Frederick Street,
Detroit MI 48211
Phone: (734) 329-8017 Fax: (313) 923-3375
RCRA & CRW liquid wastewater

Environmental Soil Management of New York,
LLC (ESMI of New York)
304 Towpath Road,
Fort Edward, NY 12828
Phone: (518) 747-5500 Fax: (518) 747-1181
Petroleum contaminated soil

Environmental Soil Management of NH
67 International Dr.
Loudon, NH 03307
Phone: (603) 783-0228 Fax: (603) 783-0104
Petroleum contaminated soil

Triumvirate (Formerly EnviroSafe Corporation
Northeast & Jones Environmental Services)
263 Howard Street,
Lowell, MA 01852
Phone: (978) 453-7772 Fax: (978) 453-7775
RCRA & TSCA liquid and solid

Hazelton Creek Properties, LLC*
(Hazelton Mine Reclamation Project)
280 South Church St.,
Hazelton, PA 18201
Phone: (570) 574-1010 Fax: (570) 457-3395
Fresh, brackish or marine dredge material, coal ash,
cement kiln dust, lime kiln dust, co-gen ash, regulated
fill
*Please note that if this facility is to be used, each bin
letter will require an additional 10 day (or more) waiting
period on top of the 15 day lab period designated in the
specs to allow for PADEP review.

Heritage Hazardous Waste Landfill (Heritage
Environmental Services, LLC)
4370 W County Rd 1275 N
Roachdale, IN 46172
Phone: (765) 435-2704 Fax: (315) 687-3898
Hazardous Wastes, Asbestos

Manchester Landfill
311 Olcutt St.,
Manchester, CT 06040
Phone: (860) 647-3248 Fax: (860) 647-3238
Municipal solid waste, non-hazardous waste,
contaminated soil

Northeast Lamp Recycling, Inc.
250 Main Street,
East Windsor, CT 06088
Phone: (860) 292-1992 Fax: (860) 292-1114
CRW solid waste, mercury containing devices &
universal waste

Stericycle (Northland Environmental, LLC)
(aka PSC Environmental Systems)
275 Allens Ave.,
Providence RI 02905
Phone: (401) 781-6340 Fax: (401) 781-9710
RCRA liquid and solid

Ontario County Landfill
(Managed by Casella Waste)
3555 Post Farm Road,
Stanley, NY 14561
Phone: (585) 526-4420 Fax: (585) 526-5459
Municipal solid waste, non-hazardous waste solid,
special wastes including asbestos, ash from
boilers/incinerators, contaminated soil, demo debris

Paradise Heating Oil, Inc.
Quimby Street,
Ossining, NY 10562
Phone: (631) 926-2576 Fax: (718) 294-2226
CRW waste oil liquid

Phoenix Soil, LLC
58 North Washington Street
Plainville, CT 06062
Phone: (860) 747-8888 Fax: (203) 757-4933
Contaminated Soil

Red Technologies Soil
232 Airline Avenue
Portland, CT 06980
Phone: (860) 342-1022 Fax: (860) 342-1042
Temporary Storage & Transfer of contaminated soil

Republic Services Conestoga Landfill
420 Quarry Road
Morgantown, PA 19543
Phone: (610) 286-6844 Fax: (610) 286-7048
MSW, C&D debris, residual waste, contaminated soil,
asbestos *Please note that if this facility is to be used,
each bin letter will require an additional 10 day (or
more) waiting period on top of the 15 day lab period
designated in the specs to allow for PADEP review.

Stericycle (Formerly Republic Environmental
Systems (aka Philip Services Corporation (PSC)
Republic)
2869 Sandstone Dr.,
Hatfield PA 19440
Phone: (215) 822-8995 Fax: (215) 997-1293
RCRA & TSCA industrial solid & sludge, aqueous
waste, contaminated soil, PCB waste, oil & petroleum
waste, organic waste

Soil Safe, Inc.
378 Route 130, Logan Township,
Bridgeport NJ 08085
Phone: (410) 872-3990 x1120
Fax: (410) 872-9082
Soil contaminated with petroleum or metals, some
industrial waste solids

The Southbridge Recycling & Disposal Park
165 Barefoot Rd.
Southbridge, MA 01550
Phone: (508) 765-9723, (603) 235-3597
Fax: (508) 765-6812
MSW, non-hazardous C & D waste, contaminated soil
for cover

Stablex Canada, Inc.
760 Industrial Blvd.
Blainville Quebec J7C 3V4
Phone: (450) 430-9230 Fax: (450) 430-4642
RCRA liquid and solid, industrial wastes

Ted Ondrick Company, LLC
58 Industrial Road,
Chicopee, MA 01020
Phone: (413) 592-2566 Fax: (413) 592-7451
Petroleum contaminated soil

Tradebe Treatment & Recycling
136 Gracey Ave.
Meriden, CT 06451
Phone: (203) 238-8114 Fax: (203) 238-6772
RCRA, CRW wastewater, oil, hazardous waste fuels,
hazardous and non-hazardous waste water

Tunnel Hill Reclamation
2500 Township Road, 205 Route 2
New Lexington, OH 43764
Phone: (914) 713-0203 Fax: (914) 713-0672
Municipal solid waste, non-hazardous waste,
contaminated soils

Waste Management
RCI Fitchburg Landfill
Fitchburg Princeton Road,
Westminister, MA 01473
Phone: (978) 355-6821 Fax: (978) 355-6317
Solid: MSW, non-hazardous waste, C&D, contaminated
soil for use as cover material under MADEP COMM-97
policy

Turnkey Landfill (Waste Management of NH)
TLR III Refuse Disposal Facility
90 Rochester Neck Road, PO Box 7065
Rochester, NH 03839
Phone: (603) 330-2197 Fax: (603) 330-2130
Solid: MSW, C&D, PCB remediation waste (<50ppm),
virgin petroleum contaminated soil, CRW solid waste

The category of material accepted by each facility listed above is for informational purposes only. The Contractor shall verify facility acceptance of each type of regulated item.

(2) Submittals

Thirty (30) days prior to commencement of work involving the management of regulated items, the Contractor shall submit to the Engineer for approval, the following documentation:

1. Copy of Spill Contractor Permit registration issued by the CTDEEP.
2. Hazard communication training for all employees performing this work.
3. Names of the treatment facilities, recycling facilities and/or disposal facilities the Contractor intends to use to receive each type of regulated item.
4. Hazardous Material Transporter USDOT Certificate of Registration for each transporter.
5. Hazardous Waste Transporter Permit for the State of Connecticut, the destination state(s), and all other applicable states for each transporter.

Contractor shall provide the Engineer with a minimum of 48 hours notice in advance of scheduling, changing or canceling work activities.

(3) Regulated Item Management Provisions

(a) General Requirements

The Contractor's OSHA Competent Person shall be in control on the job site at all times during hazardous material management work activities. This person must be capable of identifying existing hazards, possess the authority to implement corrective measures to reduce/eliminate the hazards, comply with applicable Federal, State and Local regulations that mandate work practices, and be capable of performing the work of this contract. All employees who perform regulated material management related work shall be properly trained and qualified to perform such duties.

All labor, materials, tools, equipment, services, testing, insurance, and incidentals which are necessary or required to perform the work in accordance with applicable governmental regulations, industry standards and codes, and these specifications, shall be provided by the Contractor.

Ladders and/or scaffolds shall be in compliance with OSHA requirements, and of adequate length, strength and sufficient quantity to support the scope of work. Use of ladders/scaffolds shall be in conformance with OSHA 29 CFR 1926 Subpart L and X requirements.

Work performed at heights exceeding six feet (6') shall be performed in accordance with the OSHA Fall Protection Standard 29 CFR 1926 Subpart M including the use of fall arrest systems as applicable.

Inventory data from investigative surveys throughout the buildings are included herein and are presented for informational purposes only. Under no circumstances shall this information be the sole means used by the Contractor for determining the quantities or extent of the regulated items to be managed. The Contractor shall be responsible for verification of all field conditions affecting performance of the work. The Contractor shall submit to the Engineer for concurrence any additional items not listed herein that it believes to be regulated items included under this item. However, compliance with applicable requirements is solely the responsibility of the Contractor.

The Engineer will provide a Project Monitor to monitor the activities of the Contractor and inspect the work required. Environmental sampling shall be conducted as deemed necessary by the Engineer. Spill areas shall be cleaned by the Contractor until accepted by the Engineer. The Engineer may sample the spill area to demonstrate Contractor compliance with an acceptable standard.

(b) Personnel Protection

Prior to commencing work, the Contractor shall provide hazard communication training to all employees as necessary in accordance with OSHA 29 CFR 1926.59 and 29 CFR 1910.1200 and instruct all workers in all aspects of personnel protection, work procedures, emergency procedures and use of equipment including procedures unique to this project. Worker health and safety protocols that address potential and/or actual risk of exposure to site specific hazards are solely the responsibility of the Contractor.

The Contractor shall provide respiratory protection that meets the requirements of OSHA as required in 29 CFR 1910.134 and 29 CFR 1926.1000. A formal respiratory protection program, including appropriate medical surveillance, must be implemented in accordance with OSHA standards. The Contractor shall, as necessary, conduct exposure assessment air sampling, analysis and reporting to ensure the workers are afforded appropriate respiratory protection.

The Contractor shall provide and require all workers to wear appropriate personnel protective equipment, including protective clothing and respiratory protection, as required, within regulated work areas which exceed OSHA Personnel Exposure Limits (PELs) or when handling hazardous materials.

(c) Regulated Item Management Work Procedures

The Contractor shall not begin work until the Project Monitor is on-site.

Prior to beginning work on-site, the Contractor shall prepare waste characterization profile forms for each type of waste stream to be generated and forward such forms to the Engineer for review,

approval and signature. Upon approval, the Contractor shall forward such forms to the appropriate disposal facilities for acceptance.

The Contractor shall utilize all appropriate engineering controls and safety and protective equipment while performing the work in accordance with OSHA, USEPA, USDOT, CTDEEP and Connecticut Department of Public Health DPH regulations.

The Contractor shall employ work practices so as to minimize the disturbance of the constituents in the regulated items, and prevent breakage and spills. In the event of a spill, the Contractor shall cordon off the area and notify the Engineer. The Contractor is responsible to have spills and the effected areas decontaminated to the acceptance of the Engineer by personnel trained in hazardous waste operator emergency response.

The Contractor shall carefully and properly remove, handle, pack, label and manifest all of the regulated items in waste containers specified and suitable to contain the waste in accordance with all federal and state regulations.

Prior to transportation and recycling and/or disposal, all proper USEPA, OSHA, CTDEEP and USDOT labels and placards shall be affixed to the waste containers and hazardous materials shipping papers such as waste manifests/bills of lading shall be completed.

Prior to construction activity which would disturb such materials, properly remove, handle, pack, label, transport, manifest and recycle or dispose of the regulated items from those listed below:

The following hazardous/ regulated materials, wastes and items have been identified.

- **Connecticut Regulated Waste (CRW) – oil in transformers, PCB ballasts**
- **Universal waste (UW) – used electronics, Hg lamps, ampoules & switches**
- **Low-Level Radioactive source - smoke detectors**

See Table 6 (5 pages) attached for the Inventory of HAZMAT Regulated item.

Upon discovery of any previously unidentified regulated items during renovation activities, the Contractor shall immediately notify the Engineer and work shall cease in that area until the Engineer can determine the extent of any impact and proper handling procedures are implemented.

Upon discovery of any previously unidentified regulated items during renovation activities, the Contractor shall immediately notify the Engineer and work shall cease in that area until the Engineer can determine the extent of any impact and proper handling procedures are implemented.

(d) Waste Disposal

Efforts shall be made to recycle the constituents of the regulated items rather than dispose of them in accordance with the waste minimization efforts required under RCRA.

RCRA hazardous waste shall not be stored on the job site in excess of 90 calendar days from the accumulation start date.

Connecticut Regulated Waste shall not be transported to a RCRA or TSCA permitted facility for disposal, unless otherwise allowed by the Engineer in writing.

All non-RCRA hazardous waste materials, regulated waste materials and recyclable waste items shall be manifested separately from RCRA and TSCA hazardous waste, and documented properly on non-hazardous waste manifests, waste shipment records, bills of lading or other appropriate shipping papers for transportation to the recycling and/or disposal facility.

The Contractor shall prepare each lab pack list and shipping document (manifests, waste shipment records, bills of lading, etc.) with all of the required information completed (including types of waste, proper shipping name, categories, packing numbers, amounts of waste, etc.) in accordance with applicable federal and state regulations. The document will be signed by an authorized agent representing ConnDOT as the Generator for each load that is packed to leave the site.

The Contractor shall forward the appropriate original copies of shipping papers to the Engineer the same day the regulated items leave the project site.

All vehicles departing the site transporting hazardous materials shall display proper USDOT placards, as appropriate for the type of waste being transported.

(e) Project Closeout Documents:

Within thirty (30) days after completion of the on-site project work, the Contractor shall submit to the Engineer copies of the following completed documents:

1. Hazardous Waste Manifests
2. Waste Shipment Records/Bills of Lading
3. Recycling Receipts

Documents 1. through 3. must include the signature of an authorized disposal facility representative acknowledging receipt of hazardous materials.

Method of Measurement:

The work of “Handling and Disposal of Regulated Items” shall be provided for in accordance with Article 1.04.05 – Extra Work.

Basis of Payment:

The work of “Handling and Disposal of Regulated Items” shall be paid for in accordance with Article 1.04.05 – Extra Work, which price shall include the management, removal, handling, packing, labeling, transport, manifesting, recycling or disposal of the regulated constituents in the specific equipment/items scheduled for impact at the project site, and all equipment, materials, tools and labor incidental to the work.

Final payment will not be made until completed copies of all Manifest(s), Waste Shipment Records, Bills of Lading and/or Recycling Receipts have been provided to the Engineer. Once completed and facility-signed copies have been received in their entirety, the Engineer will make the final payment.

<u>Pay Item</u>	<u>Pay Unit</u>
Handling and Disposal of Regulated Items	Estimate

ITEM #0177150A - GENERAL BUILDING RENOVATION

Description: Under this item, the Contractor shall complete all work depicted on the Contract Plans and described in the CSI-formatted Specifications that make up this Major Lump Sum Item (MLSI). Refer to Form 817 Article 1.20-1.02.04 for additional information in this regard.

Any work incidental to another bid item which is not specifically described or included in the bid item, but which is required for performance and completion of the work required under the Contract, shall be considered to be included under this item.

Materials: All materials shall be as required by the Contract Plans and as described in the CSI-formatted Specifications that make up this MLSI.

Construction Methods: All methods of construction shall conform to the requirements as stipulated in the CSI-formatted Specifications that make up this MLSI.

Method of Measurement: This item will be paid for at the contract lump sum price for “General Building Renovation” complete.

Basis of Payment: This item will be paid for at the contract lump sum price for “General Building Renovation,” which price shall include all administrative and procedural requirements, material, equipment, labor, and work incidental thereto.

PAY ITEM

PAY UNIT

General Building Renovation

LS

ITEM #0969742A - PHOTGRAPHIC DOCUMENTATION

Description: Under this item, the Contractor shall engage the services of a qualified professional photographer and videographer with a minimum of 3 years’ experience on construction projects to create a visual record of the construction of the Project.

At the Preconstruction Meeting, the Contractor shall submit to the Engineer for approval the name and qualifications of all photographer and videographer that will be responsible for taking the photographs during construction.

The photographer and the videographer shall furnish to the Department a written photographic documentation release which states the following:

[Addressed to:]

Commissioner of Transportation
Department of Transportation
P.O. Box 317546
Newington, CT 06131-7546

Project Title and Number

We understand that all intellectual property rights associated with the photographic documentation prepared in direct service of the Contract shall transfer, along with the media itself, to the Department. We agree that said photographic documentation cannot be used for any purposes, including marketing, without the expressed written consent of the Department.

Signatures of Authorized Parties:

Photographer/Videographer Signature Date

Photographer/Videographer Printed Name Date

The Contractor shall transmit the photographs and the key plan and video recordings in a zipped folder submittal package and upload into ProjectWise “01.0 – Projects-Active” under the subfolder “160_Project Photos” under the project number main folder within 7 calendar days of taking the photographs or recording the video. The specific work flow to do so will be distributed at the Preconstruction Meeting.

The Contractor shall attribute the submittal packages in ProjectWise using the following the following attributes and naming conventions:

Discipline: CTR
Main Category: CONTRACTOR
Sub Category: PROGRESS PHOTOS

Label: "Project Number-Progress Photos #XX-Date" or "Project Number-Video #XX-Date"

Description: "Progress Photos #XX – Date" or "Video #XX-Date"

Submittal packages shall be limited to 100 MB; larger packages will need to be broken up.

After uploading photographs and the key plan or the video recording, the Contractor shall provide e-mail notification to submittal reviewers and other key personnel at their business e-mail address that the submittals have been uploaded and are available for review. The Contractor shall provide a web link to the zipped folder submittal within their e-mail notification. The Contractor shall include the following information in the notification e-mail subject line in this order: "Project Number-Progress Photos #XX-Date" or "Project Number-Video #XX-Date".

The Contractor shall transmit (2) DVD's or flash drives of all training video recordings to the Owner through the Engineer as part of the Project Closeout process.

Materials:

Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of 12 megapixels, and at an image resolution of not less than 3200 by 2400 pixels, and with vibration-reduction technology. Use flash in low light levels or backlit conditions. Individual images may be approximately 5 MB to allow the Department to print clear 8x10 photographs at a later date.

Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full high-definition mode with vibration-reduction technology. Provide supplemental lighting in low light levels or backlit conditions.

Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software. Include metadata to record the accurate date and time and GPS location data from camera.

Construction Methods:

The photographer shall take photographs with maximum depth of field and in focus. The photographer shall develop a key plan of the Project Site and building with notation of vantage points marked for location and direction of each photograph.

Before commencement of Project Work, the photographer shall take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by the Engineer. Flag construction limits before taking construction photographs. The photographer shall take 24 photographs to show existing conditions adjacent to property before starting the Work and of existing buildings either on or adjoining property to accurately record physical conditions at start of construction. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

The photographer shall take 24 photographs monthly coinciding as closely as possible with the completion of a major construction phase. Select vantage points to show status of construction and progress since last photographs were taken. Prior to taking any photographs review the proposed vantage points with the Engineer. Photographs are for a record of the progress of work. Therefore, they shall be taken at a maximum interval of one month, whether or not they show any completion of work performed during the preceding month.

The photographer shall take 24 photographs after the date of Substantial Completion for submission as Project Record Documents. The Engineer will inform photographer of desired vantage points.

The Engineer may request photographs in addition to periodic photographs specified with as few as 3 calendar days' notice except in emergency situations when the photographer shall take additional photographs within 24 hours of the request. Circumstances that could require additional photographs include, but are not limited to, the following: (1) special events planned at Project Site; (2) immediate follow-up when on-site events result in construction damage or losses; (3) photographs to be taken at off-site fabrication locations; (4) Substantial Completion of a major phase or component of the Work; and (5) Owner's request for special publicity photographs.

The videographer shall record each training session in accordance with subsection 5 of Form 817 Article 1.20-1.08.14.

Method of Measurement: This work will be measured for payment by the number of calendar months of the Project, rounded up to the nearest month.

Basis of Payment: This work will be paid for at the Contract unit price each for "Photographic Documentation" which price shall include all material, equipment, labor, intellectual property rights, and work incidental thereto, as well as any other costs to provide requirements of this specified this specification.

<u>Pay Item</u>	<u>Pay Unit</u>
Photographic Documentation	Month

ITEM #1008700A - 4" RIGID METAL MULTI DUCT CONDUIT - SURFACE

Description:

The conduit shall be a 4" multi-duct conduit system designed and engineered for in-building installation (ceiling plenum) and protection of optical fiber cable. The multi-duct concept shall maximize duct usage by compartmentalization of cables for current requirements and for future expansion. The conduit will be installed between the Communications Room and Video Data Transport Room to support fiber optic cable.

The conduit shall contain factory installed 1.25" PVC or HDPE inner-ducts within a 4" outer-duct.

As part of this item, the Contractor shall supply and install all junction boxes, conduit sweeps, couplers, terminators, hangars and other hardware required for a complete installation. All turns in the conduit shall have a minimum bend radius of 36 inches. The Contractor shall supply and install a pull tape in each separate innerduct.

Materials:

A. General:

The multi-cell conduit system shall be a pre-assembled conduit manufactured from a 4" round outerduct containing four (4) factory installed 1.25" PVC or HDPE innerducts. The innerducts shall be held together in a square configuration by a system of spacers, bands, or other mechanism. The coupling system shall be resistant to water infiltration, air loss during cable installation, and shall be capable of locking the system tightly together to not allow free twisting of the innerducts.

The conduit shall be free from defects including non-circularity and foreign inclusions. It shall be nominally uniform in color, density, and physical properties. It shall be straight and the ends shall be cut square to the inside diameter. Rigid Metal Conduit shall be Electrical Metallic Tubing (EMT).

B. Submittals

Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

Prior to beginning work and fabrication of any materials, the Contractor shall take all field measurements necessary to ensure the proper fit of the finished structure mounted conduit. This shall include all supports, brackets and hangers, fixed and flexible sweep bends, expansion/contraction fittings, junction boxes, and other structure mounted appurtenances.

- a. Layout plans and other pertinent information, including conduit lengths, locations and type of supports, sweep-bends, expansion fittings, junction boxes, etc.
- b. Commercial items shall be identified by manufacturer, trade name and catalog number. Catalog sheets, including pertinent specifications, shall be included with the submission.
- c. Complete fabrication details, including material and galvanizing specifications, for all conduit supports, brackets and hangers, hardware, field fasteners including chemical anchorages, etc.
- d. All field measurements shall be submitted for reference to the reviewer.

C. Electrical Metallic Tubing:

All components of the conduit system shall meet or exceed the following specifications and standards:

1. ANSI C80.3 Electrical Metallic Tubing (EMT-S)
2. NFPA-70 (NEC) Article 358
3. UL 6
4. UL 514B
5. UL 797

The conduit system shall be a complete system with all fittings required for a complete installation:

Deflection Fittings
Offset Fittings
Expansion/Contraction Fittings
Lubrication Fittings
Repair Kits
Installation Accessories
Stand Off Fittings
Entrance Fittings

Galvanized outer-duct shall be hot dipped galvanized inside and out; conduit shall be smooth and free from burrs and coated with rust inhibitor.

EMT shall be supplied in 10 foot lengths with a length tolerance of $\pm 1/2$ ". Conduit shall be supplied with set-screw couplings.

Each section of EMT conduit shall be supplied with one set-screw coupling that allows straight sections and fittings to be joined without spinning the conduit. The coupling shall be galvanized and have four set screws to lock the coupling in place.

The EMT conduit system shall be designed so that the assembly of components can be accomplished in the following steps:

- a. Loosen set screws on coupling to allow for insertion
- b. Insert male into female and coupling forward to bottom, ensuring alignment of innerducts
- c. Tighten set screws

The EMT conduit system shall offer a complete line of fixed and flexible sweep-bends with system compatible bell and spigot ends. The EMT conduit system shall offer and the Contractor shall utilize the following standard fixed sweep-bends:

Radius	Bend	System
4 ft. & 3 ft.	11.25°, 22.5°, 45°, 90°	4-way

Note: Direction changes shall not exceed 90 degrees.

All bends, including flexible sweeps, shall have a minimum radius of 3 ft. (900 mm). The inner-duct system shall be solvent welded to the coupling body; supported by a moveable spacer every 1 ft. (300 mm). The bends shall not violate the minimum bending radius of the fiber optic cable.

All bends shall have nylon inner ducts, or approved equivalent, installed to prevent burn-through in accordance with test procedure outlined in GR-2884 Issue 1 Section R3-35 and R3-36.

The inner-duct shall always remain flush to the end of the flexible elbow, even when bending. PVC inner ducts shall not be allowed in bend and sweeps.

The following performance requirements shall be met:

Yield	30,000 psi (200 MPa)
Tensile	50,000 psi (345 MPa)
Hardness	Rockwell "B" 55-65

D. Structure Mounted Conduit Supports

For applications in which the multi-cell conduit system is specified on the plans and/or by the Engineer to be attached to a structure, hanger assemblies and conduit support devices shall be provided and installed. These hanger assemblies and support devices shall be designed for application to the specific structure for which they will be used, and their materials and design shall be approved by the Department prior to their use.

Threaded rods, anchor bolts, nuts and washers shall conform to ASTM A449 and shall be galvanized in accordance with ASTM A153.

All hex nuts shall be “Prevailing Torque Reusable Type Lock Nuts.”

E. Innerduct:

The inner-duct in straight lengths shall be manufactured from PVC or high density polyethylene (HDPE). Innerducts shall be factory treated with atomized silicone or manufactured in a manner to reduce friction during pulling of fiber optic cable.

Innerduct to be used in bends and sweeps shall have a minimum burn through time of 90 minutes when tested in accordance with Telcordia (formerly Bellcore) GR-2884 Issue 1 Section R3-35, and R3-36.

PVC inner ducts shall not be allowed in bends and sweeps. Only nylon or HDPE innerduct shall be used in bends and sweeps.

The innerducts shall have a permanent dry lubricant extruded within the inner wall and shall incorporate longitudinal ribs within the inner wall. The innerducts shall have a nominal size of 1.25” and shall consist of 4 unique colors: white, red, orange, and yellow. Innerduct colors shall be oriented in a clockwise direction as specified above, looking at the spigot end of the multi-cell conduit system. The white innerduct shall be located directly under the print line on the outerduct.

Each inner-duct shall include a provision for tying off a pull line.

F. Junction Boxes

Junction boxes shall be sized in accordance with the requirements of the National Electric Code Article 314.28 and applicable tables of Chapter 9, and manufacturer recommendations determined based on the size and number of conduits attached to the junction box.

The junction box size shall be a minimum of 24” high X 24” wide X 10” deep

G. Conduit Testing:

The pull tape shall consist of a polyester tape. The pull tape shall be NEPTCO Part No. DP1250P, or approved equal, for cable sizes of less than 97 fibers and NEPTCO Part No. DP1800P, or approved equal, shall be used for cable size of 97-288 fibers.

The pull tape shall have the following properties:

- 1250 lb. to 1800 lb. tensile strength
- flat, not round, construction
- printed foot markings
- pre-lubricated for reduced pulling tension at start of cable pull
- low susceptibility to absorption of moisture; moisture resistant

Construction Methods:

A. General:

A silicone, non-petroleum based lubricant on the coupling body may be used to facilitate installation.

EMT conduit shall extend into junction boxes for installation of grounded end bushings.

Conduits and inner-duct entering accessible conduit terminal points (e.g. junction boxes) shall be capped or sealed. Conduits containing inner-duct shall be plugged using a quadplex expansion plug inside the conduit around the inner-duct. Inner-duct containing one cable shall be plugged using an expandable cable seal off. Conduit terminators and seals shall be furnished and installed to maintain the integrity of the FM-200 fire suppression system in any spaces where the conduit system terminates.

B. Structure Mounted Conduit Supports and Junction Boxes

The Contractor shall submit to the Engineer for approval a proposal detailing the installation method of the structure-mounted conduit and junction box including the spacing between the conduit supports. The Contractor shall support the conduit as recommended by the manufacturer and approved by the Engineer.

Structure-mounted conduit and junction box shall be installed where indicated on the plans; using mounting brackets and/or clamps as detailed on the plans or as directed by the Engineer. The Contractor shall furnish and install supplemental steel supports attached to existing structural steel as needed.

Anchor bolts for conduit supports shall be drilled and anchored into building concrete only in designated areas as shown on the Contract plans. The anchorage system shall be installed per the manufacturers' recommendations.

C. Conduit Testing:

The Contractor shall test each cell of the multi-cell conduit after the conduit is installed. All testing shall be performed using the procedures and mandrel size recommended by the multi-cell or conduit manufacturer. The Contractor will be required to install a pull-tape within each cell of the conduit. The intention of the conduit testing is to verify the integrity of the completed system; therefore, this testing will only be allowed to commence once the conduit system has been completely installed. Testing shall be performed in the presence of the Engineer. The Engineer will document the date, time, and the results of the testing and shall submit this information to Highway Operations for record keeping purposes.

D. Pull Tape:

The Contractor shall install pull tape, by hand pulling, blowing, or via vacuum method, into each empty conduit and empty cell within a multi-cell conduit during conduit installation. The Contractor shall install the pull tape after conduit testing has been completed. The Contractor shall neatly coil and secure 10 ft. of slacked pull tape at each end of the conduit (Communications Room and Video Data Transport Room).

The pull tape shall be field installed within each innerduct for the purpose of attaching to, and pulling of, the fiber optic cable. The Pulling Tape shall be tied off to an expanding Neoprene Plug.

E. As-Built Plans:

The Contractor shall advise the Engineer of any change of measurement or layout of the Contract Plans. Upon completion of construction but prior to acceptance of the Project, the Contractor shall furnish as-built plans in 2 ft. by 3 ft. standard plan sheets (hard copy) form and in an electronic portable document format (.pdf).

Method of Measurement:

The conduit shall be measured for payment by the actual number of feet of the type and size installed and accepted. Fixed and flexible sweep-bends, flexible metal conduit, conduit fittings, and junction box will not be measured for payment but shall be included in the pay item for the conduit of the type and size specified. The measured length shall be from end to end along the centerline through all fittings.

The pull tape and the poly-line conduit testing will not be measured for payment but shall be included in the pay item for the conduit of the type and size specified.

Basis of Payment:

This work to be done for this specification shall be paid for at the Contract unit price per foot for conduit of the size and type indicated, within the limits shown on the plans and in the details. This price shall include all materials required including fixed and flexible sweep-bends, conduit fittings, junction boxes, caps, entrance fittings, pull tape, inserts, ground wire, structure hanger assemblies and conduit support devices, chemical anchors, equipment, tools, labor and work incidental thereto.

PAY ITEM

PAY UNIT

4" Rigid Metal Multi Duct Conduit - Surface

LF

ITEM #1108504A - EQUIPMENT RACK

Description:

I. General

- A. This specification specifies the requirements for furnishing and installing Equipment Racks intended for the new Video and Data Transport Room G303 (VDTR) of the renovated Newington Highway Operations Center, as shown on the Drawings and detailed in these specifications.

B. Scope

The equipment cabinets shall serve as operational housing for the Newington Highway Operations Center intelligent transportation system, video management and communications equipment.

All rack assemblies shall house 19-inch mountable equipment.

C. Applicable Publications:

Publications listed below form a part of these specifications to the extent referenced. The publications are referred to in the text by the basic designation only.

1. NEMA Standard 250-2014
2. UL50 and UL50B
3. NEC

D. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- a. Product Data sheets including information regarding materials, finishes and accessories.
- b. Shop Drawings indicating the location and orientation of the equipment racks, along with proposed locations of all vertical cable management connections to the overhead cable ladder.
- c. Test procedures and test results.
- d. Quality Assurance Submittals.

- e. Maintenance Data to include in the operations and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

E. Quality Assurance:

1. The Equipment Rack installer shall have a minimum of 4 successfully completed projects within the last 4 years installing equipment racks in a data center environment of similar size and complexity.
2. The Equipment Rack installer shall provide proof of experience and knowledge for previous project references verifying the qualifications requirements described herein this specification. All references shall include project description, company name, contact name, and phone number.
3. The Equipment rack installer shall submit the name and qualifications of the installers as part of the submittal package prior to installation.

F. Testing:

1. The Contractor shall be responsible for all testing and documentation required for approval and acceptance of this Item.
2. Pre-Installation Testing
 - a. The Contractor shall be required to perform quality control testing on at least 10% of the racks.
 - b. The Contractor shall submit test procedures and documented test results to the Engineer. The test procedures shall document the nature of test activities to be performed.
 - c. The test procedures shall be submitted to the Engineer for approval prior to initiation of the testing.
 - d. A copy of the final test procedures shall be submitted to the Engineer prior to commencement of testing.
3. The testing and test procedures shall include, but not be limited to the following:
 - a. Visual Inspection - The Contractor along with the engineer shall perform detailed visual inspection to confirm that the following aspects of the racks are in compliance with the requirements of this Specification:
 - i. General appearance: cabinet dimensions, finish, top, base and side panels.

- ii. Rack frame and rails, presence of all required accessories, power distribution units, and mounting hardware.
4. Proof-of-Performance Testing - The Contractor shall energize each cabinet and confirm proper operation of power distribution units.

G. Delivery, Storage, and Handling

1. The Contractor shall deliver, store, handle and install all materials and equipment in such a manner as not to degrade quality, serviceability or appearance.
2. The Contractor shall be responsible for storage of the materials and equipment prior to installation in a clean, dry location free from construction dust, precipitation and excess moisture.
3. The Contractor shall be required to replace any damaged materials and equipment, as determined by the Engineer, at no additional cost to the Department.

H. Manufacturer's Requirements

1. A minimum of (10) years' experience in the design, manufacture, and testing of Equipment Racks is required. The system shall be designed and manufactured according to world class quality standards. The manufacturer shall be ISO 9001 certified.

Materials:

A. Equipment Rack General Requirements:

1. The contractor shall furnish 28 equipment Racks between 78-84 inches overall height (external height with base), 40 to 45 rack units high, 24 inches wide, and 36 inches deep as shown on the plans. The contractor shall furnish all accessories as detailed in this specification.
2. The equipment rack shall be manufactured by Panduit, Legrand, or approved equal.
3. Each equipment rack maximum load-carrying capacity shall be no less than 2000 lbs.

4. Equipment rack frame sides shall be minimum 14-gauge steel.
5. Equipment rack side panels shall be minimum 16-gauge steel.
6. The Equipment Racks shall include non-threaded round or square mounting holes on mounting rails to accommodate 19-inch wide equipment as per the Drawings and intended application. The equipment racks shall include cage nuts, screws, and washers for 50% of every hole of every mounting rail supplied.
7. The Equipment Racks shall be supplied complete with removable tops, bases, and blank panels to fill unoccupied spaces on the front mounting rails. Louvered or solid side dress panels shall be provided for the end units only and shall not be supplied between ganged racks. The racks shall not be supplied with front or rear doors.
8. The Equipment racks shall each include 3 pairs of adjustable mounting rails that can be mounted at any location from front to back. The mounting rails shall accommodate 19-inch wide equipment and shall be made of minimum 12 gauge steel. Equipment rack rails shall be accessible and adjustable after racks are installed and ganged together.
9. Each equipment rack shall include one 3-rack unit cantilevered vented shelves with mounting hardware.
10. Each equipment rack shall be furnished with vertical and horizontal cable management which shall include:
 - One 3” wide, by 3” deep, vertical wiring duct with snap on cover shall be furnished for connection to the overhead cable ladder. The wiring duct length shall be continuous from the bottom of the equipment rack to six inches below the overhead ladder-type cable tray. The wiring duct shall be PVC with wide fingers and wide slots which can be cut to any length. The wiring duct shall be supplied with mounting hardware for attachment to the sides and rear of the equipment rack.
 - One 4” wide, by 5” deep, vertical wiring duct with snap on cover shall be furnished for connection to the overhead cable ladder. The wiring duct length shall be continuous from the bottom of the equipment rack to six inches below the overhead ladder-type cable tray. The wiring duct shall be PVC with wide fingers and wide slots which can be cut to any length. The wiring duct shall be supplied with mounting hardware for attachment to the sides and rear of the equipment rack.
 - Two 3.5” wide, ladder type, internal rack mounted vertical cable managers shall be mounted on both sides of the equipment rack for the entire length and shall be adjustable to any position front to back. The internal rack

mounted vertical cable manger shall be supplied with mounting hardware for attachment to the sides of the equipment rack.

- Three 19" wide 2 rack unit high horizontal rail mounted cable management units shall be furnished with each equipment rack.

11. The Equipment Racks shall be supplied with a minimum 3 inch base and leveling feet.
12. Each Equipment Cabinet shall be furnished with two (2) 120V/208V 60 Hz vertical power distribution assemblies for the equipment in the racks, each of which shall be connected to a dedicated circuit on the VDTR overhead track busway (CSI 262728). The power distribution assemblies shall have 20 C13 receptacles and 4 C19 receptacles with a digital power amp meter. The vertical power distribution assemblies shall be rack mountable attached to each side of the equipment rack, and shall be equipped with a NEMA L6-30P plug with strain relief for mating with a twist lock receptacle inside each equipment rack.
13. All Equipment Racks shall be supplied with required installation hardware and ganging kits. Equipment rack frames shall be ganged together at both the front and rear.
14. The contractor shall furnish a copper vertical mounted ground bus bar for connecting equipment in each equipment rack.
15. The contractor shall furnish a copper overhead ground bus bar to commonly ground all equipment racks and patch panel equipment racks.
16. Each equipment rack shall be grounded to the overhead ground bus bar with an AWG #6 green colored jacketed cable.
17. Each equipment rack and ground bus bar shall be connected to the overhead ground bus using a one-hole compression-type lug. Grounding conductors shall be joined with mechanical crimped sleeves designed to have two crimps per side.
18. Each equipment rack grounding conductor shall be terminated with a mechanical crimped type lug designed to have two crimps. The grounding conductor shall be made of copper alloy.
19. Equipment racks shall be black in color.
20. All equipment racks shall be new and from the same manufacturer.

B. Patch Panel Rack General Requirements

1. The contractor shall furnish 4 patch panel racks between 78-84 inches overall height (external height with base), 40 to 45 rack units high, 30 inches overall width (including vertical cable mangers) and a minimum of 36 inches overall depth (including cable mangers). The patch panel racks shall be a four post type rack with vertical cable mangers installed each end and between ganged racks.
2. Each patch panel rack maximum load-carrying capacity shall be no less than 2000 lbs.
3. Patch panel rack frame sides shall be minimum 14-gauge steel.
4. Patch panel rack side panels shall be minimum 16-gauge steel.
5. The patch panel racks shall include non-threaded round or square mounting holes on mounting rails to accommodate 19-inch wide equipment as per the Drawings and intended application. The equipment racks shall include cage nuts, screws, and washers for 50% of every hole of every mounting rail supplied.
6. The patch panel racks shall be supplied complete with removable tops, bases, and blank panels to fill unoccupied spaces on the front mounting rails. Louvered or solid side dress panels shall be provided for the end units only and shall not be supplied between ganged racks. The racks shall not be supplied with front or rear doors.
7. The patch panel racks shall each include 2 pairs of adjustable mounting rails that can be mounted at any location from front to back. The mounting rails shall accommodate 19-inch wide equipment and shall be made of minimum 12 gauge steel. Equipment rack rails shall be accessible and adjustable after racks are installed and ganged together.
8. The patch panel racks shall be supplied with a minimum 3 inch base and leveling feet.
9. Each Patch Panel Rack shall be supplied with two (2) 120/208V 60 Hz vertical power distribution units for the equipment in the racks, each of which shall be connected to a dedicated circuit on the VDTR overhead track busway (CSI 262728). The power distribution assemblies shall have 20 C13 receptacles and 4 C19 receptacles with a digital power amp meter. The vertical power distribution assemblies shall be rack mountable, attached to each side of the patch panel equipment rack, and shall be equipped with a NEMA L6-30P plug with strain

relief for mating with a twist lock receptacle inside each patch panel equipment rack.

10. All Patch Panel Racks shall be supplied with required installation hardware and ganging kits. Patch panel rack frames shall be ganged together at both the front and rear.
11. The contractor shall furnish a copper vertical mounted ground bus bar for connecting equipment in each patch panel equipment rack.
12. Each Patch Panel Rack shall be connected to the overhead bus bar with an AWG #6 green colored outer coating cable.
13. Each Patch Panel Rack shall be connected to overhead ground bus bar using a one-hole compression-type lug. Grounding conductor splices shall be joined with mechanical crimped sleeve designed to have two crimps per side.
14. Each Patch Panel Rack grounding conductor shall be terminated with a mechanical crimped type lug designed to have two crimps. The grounding conductor shall be made of copper alloy.
15. Patch panel racks shall use vertical cable management systems connected between the patch panel rack frames to organize, manage, and protect network cabling. Each patch panel rack shall include the following vertical and horizontal cable management:
 - 2 vertical patch panel cable management systems 6 inches wide, 78-84 inches in height, and 10-14 inches deep. The vertical cable management shall include fingers and slack spools along the entire length to allow cables to exit at any location and to loop cable slack. Ganged patch panel racks shall have a single vertical patch panel 6" wide.
 - 6- 19" wide rack mounted adjustable horizontal patch panel cable management systems, 3 rack units high, that connect to the vertical cable management on either side of the patch panel rack. The horizontal cable management shall include fingers along the entire length to allow cables to exit at any location. All horizontal and vertical cable management systems shall protrude 6 inches from the front mounting rails.
 - 2- 6" wide internal rack mounted vertical cable ladders shall be mounted on both sides of the patch panel equipment rack for the entire length and shall be adjustable to any position front to back. The internal rack mounted vertical cable manger shall be supplied with mounting hardware for attachment to the sides of the equipment rack.

16. The patch panel rack cable management system shall include bend radius control to support cables transitioning to the vertical pathway.
17. The patch panel rack cable management system shall include integrated cable retainers on the end of each bend radius control finger to simplify installation and maintenance.
18. The patch panel rack cable management system shall use hinged doors capable of being opened to 110° to the left or right to provide complete access to cables in the vertical raceway.
19. Equipment racks shall be black in color.
20. All patch panel racks shall be new and from the same manufacturer.

Construction Methods:

A. Installation

1. The Contractor shall install the rack assemblies as indicated on approved submittal drawings. Each equipment rack or patch panel equipment rack shall be installed on top of the access flooring in a way to not obstruct any vented access flooring panels. Each equipment rack shall be properly leveled and installed in proper alignment of the overhead cable ladder.
2. The contractor shall coordinate installation of the equipment racks with the ladder-type cable tray and fiber optic cable management system installation to ensure vertical cable management aligns and properly enters the ladder-type cable tray and fiber optic cable management (Item 1108539A).
3. The contractor shall fasten all neighboring racks in each row by use of ganging kits.
4. The contractor shall install all equipment rack and patch panel equipment rack power distribution units so not to obstruct equipment or cable management installed at any location between the 19 inch rack rails. The power receptacles shall be installed on each side facing outwards at the rear of each equipment rack and patch panel equipment rack.
5. The equipment rack mounting rails shall be installed on the front, middle, and rear of the Equipment Racks or as directed by the engineer. The patch panel equipment rack mounting rails shall be installed on the front and rear of the racks or as directed by the engineer.

6. The contractor shall connect each rack power distribution assembly to a duplex twist lock receptacle from the track busway secured inside the rack assembly. The contractor shall secure the receptacles to the sides of each equipment rack and patch panel equipment rack.
7. Each power distribution assembly shall be connected to separate dedicated circuits on the overhead track busway.
8. The contractor shall coordinate the installation of the equipment racks and track busway (CSI 262728) to ensure all rack mounted power distribution units are properly connected and powered. The Contractor shall request and receive approval from the Engineer prior to energizing each power distribution unit.
9. The contractor shall install a copper vertical mounted ground bus bar in each equipment rack and patch panel equipment rack.
10. The contractor shall install a copper overhead ground bus bar and properly ground each equipment rack and patch panel equipment rack.
11. The contractor shall install and ground each equipment rack and patch panel equipment rack frame and each copper vertical mounted ground bus bar to the copper overhead ground bus bar. The Equipment rack grounding conductors shall be neatly and uniformly run to each equipment rack and each patch panel equipment rack.
12. The contractor shall install all internal and external vertical cable management for patch panel equipment racks and equipment racks as detailed in this specification or as directed by the engineer. The contractor shall install all horizontal cable management for patch panel equipment racks and equipment racks as directed by the engineer.

B. Protection and Cleaning

1. The Contractor shall be responsible for protecting finished surfaces from damage during fabrication, shipping, storage, and testing.

Method of Measurement: This item will be paid by each.

Basis of Payment:

This item will be paid at the Contract Price for “Equipment Rack” which price shall include all administrative and procedural requirements, equipment, labor, testing, materials, and work incidental thereto.

PAY ITEM

PAY UNIT

Equipment Rack

Each

ITEM #1108539A - MODIFY EXISTING OPERATIONS CENTER CONTROL SYSTEM

Description:

This item shall consist of furnishing, installing, and testing all ITS data cabling and connectors in floor boxes, wall jacks, Cat6A rack mounted patch panels, and surface mounted modular patch panels from locations as detailed within this specification and on the contract plans. Installing overhead fiber optic cable management system and overhead ladder cable tray in the VDTR room G303 and into the telecommunications room G116 as detailed in these specifications and on the contract plans. Installing under floor cable trough wire basket system in rooms G302, G318, G301, G300, G305, G306, G307, G114, G134 and G308 as detailed in these specifications and on the contract plans.

Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- A. Product Data including information regarding materials, finishes and accessories.
- B. Shop Drawings:

Wiring diagrams detailing cabling start point and end points with quantities and proposed labeling schema.

Equipment rack front elevation drawings for installed patch panel locations.

Equipment installation drawings indicating supports and appurtenances required for proper installation.

- C. Maintenance Data to include in the operations and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.
- D. Quality Assurance Submittals: Installer qualifications.
- E. As-Built Documentation:
 - Electronic patch panel equipment cabinet front elevation drawings in Visio 2010 format.
 - Electronic As-built wiring diagrams and point to point wiring details for UTP and coaxial wiring in Visio 2010 format. The drawings are to represent the cable installation with the outlet/floor box location designations and the appropriate outlet labelling on the drawing.
 - Electronic copy of all cabling test results.

QUALITY ASSURANCE:

- The modify existing operations center control system installer shall have a minimum of 4 successfully completed projects within the last 4 years with installing and testing low voltage communication cabling, ladder-type cable trays, fiber optic cable management systems, and cable trough wire basket systems in a data center environment of similar size and complexity.
- At least one installer shall have a BICSI certified RCDD
- The modify existing operations center control system installer shall be certified by the manufacturer for installation and testing of all low voltage CAT6A cabling and CAT6A connectors described herein this specification.
- The modify existing operations center control system installer shall provide proof of experience and knowledge for previous project references verifying the qualifications requirements described herein this specification. All references shall include project description, company name, contact name, and phone number.
- The modify existing operations center control system installer shall submit the name and qualifications of the installers and testers as part of the submittal package prior to installation.

SPARE PARTS:

Once all cabling tests have passed, the Contractor shall furnish to the Engineer spare parts that match products installed that are packaged with protective covering for storage and identified with labels describing contents, as listed below:

- 7- Category 6A patch panels with CAT6A jacks
- 5- Modular surface mounted patch panels with 36 CAT6A and 5 BNC modular jacks.

Materials:

Baseband Video Coaxial Cable – RG-6 Type

- 2.1 The baseband video coaxial cable shall be type Belden P/N 1695A
- 2.2 Precision video coaxial cable shall be utilized to transmit baseband NTSC video signals between communications equipment as described herein and elsewhere in these specifications and as shown on the intelligent transportation system (ITS) drawings. All cabling shall be plenum rated. The outer conductor shall be tinned copper braid with a minimum 95% shield coverage.

- 2.3 The center conductor shall be 18 AWG solid bare copper
- 2.4 The nominal impedance shall be 75 ohms, plus or minus 2%.
- 2.5 The nominal DC resistance of the center conductor shall be 6.4 ohms/1000ft.
- 2.6 The nominal DC resistance of the shield shall be 2.8 ohms/1000ft.
- 2.7 Coaxial cable to pass through floor box locations shall have 8 foot coils to accommodate potential future room configuration changes.
- 2.8 The cable shall be 100% sweep tested.

Unshielded Twisted Pair (UTP) Data Cables

- 2.9 Data cables shall be TIA/EIA 568B Category 6A, characterized to 500 MHz or greater, suitable for 10GBase-T local area network applications at distances of 328 feet. The outer jacket color shall be blue.
- 2.10 The UTP-based Category 6A cabling system shall use matched components from a single manufacturer and the cabling system shall be certified to deliver system performance over the lifetime of the applications for which the cabling system was originally designed to support.
- 2.11 Category 6A cable shall be used for Ethernet, serial data, and telecommunications data between communications equipment as shown on the intelligent transportation system (ITS) Drawings.
- 2.12 Category 6A cables passing through floor box locations shall have an additional 8 foot coil under the raised floor to accommodate potential floor box configuration changes.
- 2.13 Category 6A data cables shall be terminated in a rack mounted patch panel in the VDTR room. Category 6A cables shall be terminated in a modular surface mount patch panel at each operator/engineering console, wall jack, or floor box jack as detailed in these specifications and contract plans.
- 2.14 Category 6A data cables shall be capable of meeting IEEE standards for POE 802.3af and POE+ 802.3at
- 2.15 Category 6A data cables installed shall be plenum rated.

- 2.16 Category 6A cables shall be terminated with 8 pin Category 6A RJ-45 connectors in modular surface mounted patch panels, rack mounted patch panels, wall jacks, or floor box jacks.
- 2.17 Category 6A cables used for horizontal data cable wiring between patch panels, floor boxes, and wall jacks shall be Category 6A cable as required by the application and as directed by the Engineer and shall comply with the following requirements:
- Conductor: 23 AWG (solid bare copper)
 - Nominal Capacitance: 17 pF/ft.
 - Characteristic Impedance: $100\Omega \pm 20\%$
 - Maximum DC Resistance: 7.5/100m
 - Velocity of Propagation: 69% (minimum)
 - Performance @ 500 MHz: 43.9dB/100m Max Attenuation
 - Maximum Delay Skew: 45 ns/100m
 - Maximum Voltage: 300V RMS
 - Overall Nominal Diameter: 0.275 in. or less
- 2.18 Equipment located within environmentally controlled rooms shall be capable of meeting the following requirements:
- Storage Temperature: -20° to + 75° Celsius
 - Operating Temperature Range: -20° to + 75° Celsius
 - Relative Humidity: 5 to 90%, non-condensing
 - Fire Resistance: Complies with TR-NWT-000063, Issue 3.

Ladder-Type Cable Tray

- 2.1 The contractor shall furnish a ladder-Type cable tray, necessary mounting hardware, waterfall dropouts, and accessories to provide data and coaxial cable connectivity to each equipment rack located in room G303, connectivity to the telecommunications room G201, and connectivity to the communications closet G318 as detailed in these specifications and on the contract plans.
- 2.2 The Ladder-type Cable Tray shall include structural channel with threaded rod support “trapeze” hangars with hold down clips or clamps specifically manufactured for the purpose.
- 2.3 The Ladder-type cable tray shall include dividers to separate cables of different types or groups. The divider shall be consisting of aluminum and be installed at locations directed by the engineer.

- 2.4 The Ladder-type Cable Tray shall sustain a working load of 100 lbs. per linear foot with a load (safety) factor of 1.5 when tested in accordance with NEMA load test VE1-3.01. The Ladder-type cable tray shall support without collapse an additional 200 lbs. concentrated load.
- 2.5 The Ladder-type Cable Tray shall include tees, 90-degree bends, 45-degree bends, end plates, cable barriers, connectors, clamps and other fittings required to provide a complete system. The ladder-type cable tray bends shall not exceed the minimum bend allowance for all cables detailed in this specification.
- 2.6 The Ladder-type Cable Tray shall consist of aluminum ladder, 6 inches deep by 24 inches wide with standard factory splices, tees, and other required appurtenances. The ladder rung spacing shall be a maximum of 6 inches.

Fiber Optic Cable Management System

- 2.1 The contractor shall furnish a fiber optic cable management system to provide fiber optic connectivity to each equipment rack located in the VDTR room G303 as detailed in these specifications and on the contract plans. The fiber optic cable management system will follow the same layout as the overhead wire ladder detailed in the contract plans. The contractor shall furnish fiber optic cable management system vertical cable management drops with cable drop outs to each equipment rack installed in the VDTR room G303.
- 2.2 The Fiber Optic Cable Management System shall provide a closed channel allowing fiber optic cables to be protected. The fiber optic cable management system shall be sized with an internal channel a minimum of 2 inches high by 2 inches wide. The channels shall have hinged covers to provide access to the fiber optic cables.
- 2.3 The Fiber Optic Cable Management System shall consist of solid straight sections for horizontal routes, slotted straight sections for vertical drops, intersection blocks for making turns upward, downward, right or left, and into or across other horizontal routes. Vertical drops shall permit fibers to enter the equipment racks and shall provide support to the fiber optic cables and prevent exceeding the minimum bend radius for both single-mode and multi-mode fiber optic patch cables. Vertical drops shall have cable drop-outs spaced every 3.5 inches and span the entire vertical length of the equipment cabinet.
- 2.4 The Fiber Optic Cable Management System shall include fiber optic cable strain relief devices.
- 2.5 All sections shall snap-fit together and shall require no hardware to attach to other sections. All straight sections shall be able to be cut to the required length using a common handsaw.

- 2.6 The Fiber Optic Cable Management System shall include mounting hardware to attach below the Ladder-type Cable Tray as detailed in the contract plans. The Fiber Optic cable Management system hardware shall be specifically designed for the distribution and protection of fiber optic cables in an indoor communications equipment center.

Cable Trough Wire Basket System

- 2.1 The contractor shall furnish a cable trough wire basket system designed to provide fiber and data cable connectivity under the raised access flooring as detailed in these specifications and on the contract plans.
- 2.2 The cable trough shall be made of modular, underfloor cable wire basket system designed to route data cables beneath raised floors. Wire basket system modular sections shall include sections of continuous wire mesh, universal fitting, level changes, underfloor supports, grounding straps, cable drops, and accessories.
- 2.3 The cable trough wire basket system shall be new and made from the same manufacturer.
- 2.4 The cable trough wire basket system shall have the ability to adjust heights under the access flooring to overcome any unforeseen obstructions.
- 2.5 The cable trough wire basket system shall include a divider for separating fiber optic cables and copper data cables.
- 2.6 The cable trough wire basket system shall be made from pre-galvanized steel wire and pre-galvanized CRS. It shall be RoHS compliant and coated for corrosion resistance.
- 2.7 The wire basket system shall be made of steel wires and formed into a standard wire mesh pattern with intersecting wires welded together. All wire ends along the wire basket sides shall be tee welded during manufacturing for safety of cables and installers.
- 2.8 The wire basket system sections shall be 18 inches wide and 6 inches deep. Sections shall come in minimum 24 inch long sections.
- 2.9 The wire basket system shall use universal intersection fittings as shown on the contract plans.

Category 6A Patch Panels

- 2.1 The contractor shall furnish 75 CAT6A rack mounted patch panels with each patch panel including 24 CAT6A rated jacks located in the VDTR room G303 as detailed in these specifications and on the contract plans. The CAT6A rack mounted patch panels shall each provide 24 fixed or modular CAT6A rated jacks in 1 rack unit. CAT6A jacks shall be rated for 10GBase-T at distances of 328 feet.
- 2.2 The rack mounted patch panels shall be manufactured by Belden, Panduit, Legrand, or approved equal.
- 2.3 The CAT6A rack mounted patch panels shall be backwards compatible to all lower rated category components and compatible with voice grade telephone circuits. All patch panels shall be capable of accepting RJ-45 connectors for Ethernet data and RJ-11 connectors for voice grade telephone using a single plug in or fixed module capable of accepting both connectors.
- 2.4 The CAT6A rack mounted patch panel shall comply with ANSI/TIA/EIA-568-B.
- 2.5 The CAT6A patch panels shall be made for rack mounting in 19 inch wide patch panel equipment racks. The CAT6A rack mounted patch panels shall have a metal frame.
- 2.6 The CAT6A rack mounted patch panels shall be mounted in the approximate locations in the designated patch panel equipment racks as shown on the plans or as directed by the Engineer.

Modular Surface Mount Patch Panels

- 2.1 The contractor shall furnish 50 modular surface mounted patch panels located in rooms G300, G301, G305, G306, G307, and G308 as detailed in these specifications and on the contract plans. The contractor shall furnish 300 CAT6A plug in modules and 50 BNC plug in modules for the surface mounted modular patch panels.
- 2.2 The surface mounted modular patch panels shall be manufactured by Belden, Panduit, Legrand, or approved equal. The modular patch panel shall be manufactured by the same manufacturer of the Category 6A rack mounted patch panels.
- 2.3 The surface mounted modular patch panels shall have a releasable front faceplate to allow front access for termination. The surface mounted modular patch panels shall have optional plug in modules for Category 6A UTP/STP, RCA audio, F-type coax, Fiber-Optic LC connectors, and BNC video connectors.

- 2.4 The CAT6A plug in modules for the surface mounted patch panel shall be backwards compatible to all lower rated category components and compatible with voice grade telephone circuits. All patch panels shall be capable of accepting RJ-45 connectors for Ethernet data and RJ-11 connectors for voice grade telephone using a single plug in module capable of accepting both connectors.
- 2.5 The CAT6A plug in modules for the surface mounted patch panel shall comply with ANSI/TIA/EIA-568-B. CAT6A jacks shall be rated for 10GBase-T at distances of 328 feet.
- 2.6 The BNC plugin modules for the surface mounted patch panels shall be compatible with 75 ohm CCTV applications.
- 2.7 The modular patch panels shall be made for surface mounting within consoles, stationary tables, and cubicles. The modular patch panels shall have a metal frame.
- 2.8 The modular patch panel shall each provide 12 slots for compatible plug in jacks.

Wall Mount and Floor Box Data Jacks

- 2.9 The contractor shall furnish 9 modular floor box data jacks and 6 modular wall mount data jacks located in rooms G300, G302, G305, G303, G318, G114, and behind 55" LCD hallway monitors as detailed in these specifications and on the contract plans. The contractor shall furnish 62 CAT6A plug-in modules and 2 BNC plug-in modules for the modular floor box data jacks and modular wall mount data jacks.
- 2.10 The modular floor box and wall mount data jacks shall be manufactured by Belden, Panduit, Legrand, or approved equal. The modular floor box and wall mount data jacks shall be manufactured by the same manufacturer of the modular surface mounted patch panels and use the same interchangeable plug-in modules.
- 2.11 The modular floor box and wall mount data jacks shall have a minimum six gang front faceplate installed at all locations. The modular floor box and wall mount data jacks shall have optional plug in modules for Category 6A UTP/STP, RCA audio, F-type coax, Fiber-Optic LC connectors, and BNC video connectors.
- 2.12 The CAT6A plug in modules for the surface mounted patch panel shall be backwards compatible to all lower rated category components and compatible with voice grade telephone circuits. All patch panels shall be capable of accepting RJ-45 connectors for Ethernet data and RJ-11 connectors for voice grade telephone.

- 2.13 The CAT6A plug in modules for the surface mounted patch panel shall comply with ANSI/TIA/EIA-568-B. CAT6A jacks shall be rated for 10GBase-T at distances of 328 feet.
- 2.14 The BNC plugin modules for the surface mounted patch panels shall be compatible with 75 ohm CCTV applications.
- 2.15 The modular floor box and wall mount data jacks shall be made for surface mounting within floor boxes or on wall surfaces.

Warranty:

All installed and tested CAT6A cabling, and CAT6A connectors shall come with a manufacturer warranty that will commence from the date of installation. All manufacturer warranties shall be assigned to the Department. The CAT6A connector and cabling installer shall provide all warranty certificates in writing to the department certified by the manufacturer.

Construction Methods:

Baseband Video Coaxial Cabling:

- 3.1 The Contractor shall install video baseband coaxial cables through the overhead cable ladder and under floor cable trough between the VDTR (Room G303) Rack A01 to various modular surface mount patch panels and finished wall jacks according to the listed locations below and as shown on the contract plans. Coaxial cables shall pass through all floor box locations and be terminated by the owner contractor in a modular surface mount patch panel. Refer to contract phasing plans for installation timeline. The contractor shall install and test all coaxial cables to the following locations listed below:
 - 2 coaxial cables from rack A01 in room G303 to modular surface mounted patch panels located in each Highway Operations Center console (Room G300) for a total of 16 coaxial cables installed;
 - 2 coaxial cables from rack A01 in room G303 to modular surface mounted patch panels located in each Storm Center console (Room G301) for a total of 8 coaxial cables installed;
 - 2 coaxial cables from rack A01 in room G303 to modular surface mounted patch panels located in each engineering cubicle (Room G305) for a total of 20 coaxial cables installed;
 - 2 coaxial cables from rack A01 in room G303 to modular surface mounted patch panel located in the Collaboration workstation (Room G308) for a total of 2 coaxial cables installed;
 - 2 coaxial cables from rack A01 in room G303 to modular surface mounted patch panels located in each Engineering Office (Rooms G306 and G307) for a total of 4 coaxial cables installed;

- 2 coaxial cables from rack A01 in room G303 to 1 finished wall jack at the HOC Conference Room (Room G302) display;
- 4 coaxial cables from rack A01 in room G303 through the telecommunications room G201 and into the storage closet located in room G134;

Unshielded Twisted Pair (UTP) Data Cabling:

- 3.2 In Area A, the Contractor shall install, terminate, and test Category 6A cables from rack mounted Category 6A patch panels in VDTR room G303 Rack C03 through the overhead cable ladder and under floor cable trough to ITS floor boxes, finished wall jacks, or modular surface mount patch panels as listed below and as shown on the contract plans. Refer to contract phasing plans for installation timeline:
- 12 CAT6A cables from rack C03, through floor boxes (HOC01-HOC08) to modular surface mounted patch panels located in each Highway Operations Center console (Room G300) for a total of 96 CAT6A cables;
 - 6 CAT6A cables from rack C03 to a floor box (HOC13) located in Highway Operations Center Printer/Copier area (Room G300) for a total of 6 CAT6A cables;
 - 12 CAT6A cables from rack C03, through floor boxes (SC01-SC04) to modular surface mounted patch panels located in each Storm Center console (Room G301) for a total of 48 CAT6A cables;
 - 6 CAT6A cables from rack C03 to a wall mounted jack (HOC18) located in Highway Operations Communications Closet (Room G318) for a total of 6 CAT6A cables;
 - 2 CAT6A cables from rack C03 to a wall mounted jack (HOC14) located at the Highway Operations entrance for a total of 2 CAT6A cables;
 - 2 CAT6A cables from rack C03 to a wall mounted jack (HOC15) located at the HOC Conference Room (Room G302) for a total of 2 CAT6A cables;
 - 6 CAT6A cables from rack C03 to a floor box (HOC16) located at the HOC Conference Room (Room G302) for a total of 6 CAT6A cables;
 - 6 CAT6A cables from rack C03 to a floor box (ENG13) located in the Engineering Printer/Copier Area (Room G305) for a total of 6 CAT6A cables;
 - 6 CAT6A cables from rack C03 to two floor boxes located in the VDTR (Room G303) for a total of 12 CAT6A cables;
 - 12 CAT6A cables from rack C03 through floor box (COLLAB01) to a modular surface mounted patch panel in the Collaboration area (Room 308) for a total of 12 CAT6A cables;
 - 12 CAT6A cables from rack C03 through floor boxes (ENG01-ENG10) to modular surface mounted patch panels in the Engineering area (Room G305) for a total of 120 CAT6A cables;
 - 12 CAT6A cables from rack C03 through floor boxes (ENG11-ENG12) to modular surface mounted patch panels in the Engineering Offices (Rooms G306 and G307) for a total of 24 CAT6A cables;

- 6 CAT6A cables from rack C03 using the overhead cable ladder to a rack mounted CAT6 patch panel located in the telecommunications area (Room G201) for a total of 6 CAT6A cables;
- 3.3 In Area A, the Contractor shall install, terminate, and test Category 6A cables from rack mounted Category 6A patch panels in VDTR room G303 Rack C04 under the raised floor to equipment racks as listed below and as shown on the contract plans. Refer to contract phasing plans for installation timeline:
- 24 CAT6A cables from rack C04 under the raised floor to a rack mounted Category 6A patch panel in each equipment rack C5-C10 for a total of 144 CAT6A cables;
 - 24 CAT6A cables from rack C04 under the raised floor to a rack mounted Category 6A patch panel in each equipment rack B1-B11 for a total of 264 CAT6A cables;
 - 24 CAT6A cables from rack C04 under the raised floor to a rack mounted Category 6A patch panel in each equipment rack A1-A11 for a total of 264 CAT6A cables;
- 3.4 In Area B, the Contractor shall install, terminate, and test Category 6A cables from an audio visual rack mounted Category 6A patch panel in Storage Closet room G134 through the floor box and under floor cable trough to ITS floor boxes or finished wall jacks, as listed below and as shown on the contract plans. Refer to contract phasing plans for installation timeline:
- 6 CAT6A cables from A/V rack (Room G134) to floor boxes (TIM14, TIM09, TIM05) located in the TIM area (Room G114) for a total of 18 CAT6A cables;
 - 2 CAT6A cables from A/V rack (Room G134) to wall mounted jacks (TIM06, TIM13) located in the TIM area (Room G114) for a total of 4 CAT6A cables;
 - 2 CAT6A cables from A/V rack (Room G134) to ceiling mounted jack (TIM10) located in the TIM area (Room G114) for a total of 2 CAT6A cables;
- 3.5 The Coaxial and CAT6A cables that pass through floor box locations shall have 8 feet of neatly coiled cable slack under the raised floor to accommodate potential future room configuration changes.
- 3.6 The contractor shall route all coaxial and CAT6A cables that are entering and exiting the VDTR room G303 through conduit sealing sleeves (CSI 260544). The contractor shall seal all used conduit sealing sleeves to maintain room integrity from air leakage for the FM-200 fire suppression system.
- 3.7 All Coaxial cables shall be left unterminated and have an additional 20 feet coiled at both termination points listed above for the owner contractor to terminate. The contractor shall coordinate with the owner contractor for termination of the coaxial cable.

- 3.8 The contractor shall neatly bundle all coaxial and CAT6A cables and tie down to the overhead wire ladder and under floor cable troughs. The contractor shall keep Enterprise data cables, ITS data cables, and coaxial cables all in separate neatly secured bundles.
- 3.9 The contractor shall label all coaxial and CAT6A cables on both ends using an approved cable labeling and identification system. Cable labels shall be affixed at both ends of the physical cable and to each rack mounted CAT6A patch panel, Modular surface mount patch panel, floor box jack, and surface mount wall jack.
- 3.10 The contractor shall furnish and install air sealing grommets in access flooring at all equipment racks located in the VDTR room G303 for all CAT6A cabling entering and exiting the raised floor. All equipment rack to equipment rack CAT6A wiring shall be installed under the access flooring and not in the overhead cable ladder or across adjacent racks using front facing equipment rack wire management.
- 3.11 The contractor shall install and secure CAT6A bundles to the inside of equipment racks C03 and C04 by attaching to internal vertical wire management.

Ladder-Type Cable Tray

- 3.12 The contractor shall install ladder-type cable tray, constructed of aluminum, free from sharp burrs, edges or protrusions that could cause abrasion or laceration of the cables within the VDTR room G303, cafeteria room G400, ground floor hallway, room G318, and telecommunications room G201 as detailed in these specifications and as shown on the contract plans.
- 3.13 The contractor shall install the ladder-type cable tray within the VDTR room G303 by attaching below the structurally supported ceiling grid as detailed on the contract plans or as directed by the engineer. The contractor shall install the ladder-type cable tray to the structurally supported ceiling grid using reconfigurable load connector clips following methods as recommended by the cable tray manufacturer. The reconfigurable load connector clips shall attach to the threaded rod and trapeze hangers to support the ladder-type cable tray. The contractor shall coordinate with the structurally supported ceiling grid system to ensure the ladder cable tray is properly installed, grounded and supported. The contractor shall furnish and install supplemental steel supports attached to existing structural steel as needed. Structural support for the ladder-type cable tray within room G303 shall not penetrate the drop ceiling grid.
- 3.14 The contractor shall install ladder-type cable tray outside the VDTR room G303 to room G318 and telecommunications room G201 above the ceiling grid as detailed on the contract plans or as directed by the engineer. The contractor shall integrate the ladder-type cable tray entering the telecommunications room G201 to the

existing wire ladder located below the drop ceiling as directed by the engineer. The contractor shall attach the cable tray to existing structural steel using hangars, supports, brackets and hardware, following installation methods as recommended by the cable tray manufacturer. The contractor shall furnish and install supplemental steel supports attached to existing structural steel as needed. The contractor may attach to building concrete only in designated areas as shown on the contract drawings.

- 3.15 The contractor shall install the ladder-type cable tray above the equipment racks in room G303 so that the ladder-type cable tray is protruding a minimum of 6 inches from the rear of each equipment rack to allow for alignment of the vertical cable management as detailed in the contract plans or as directed by the engineer. The contractor will coordinate installation of the ladder type cable tray with the installed location of the equipment racks.
- 3.16 The contractor shall install vertical ladder-type cable tray down the wall in the VDTR room G303 in two locations as shown on the contract plans or as directed by the engineer to transition cabling under the floor through conduit sealing sleeves (CSI 260544) and into under floor cable troughs. The contractor shall install vertical ladder-type cable tray to the top of the raised floor. The contractor shall furnish and install air sealing grommets in access flooring to transition all coaxial and CAT6A cables from the vertical cable ladder tray to under the access flooring.
- 3.17 The contractor shall not install ladder-type cable tray through the VDTR room G303 walls. Ladder-type cable trays will transition through the VDTR room G303 walls using conduit sealing sleeves (CSI 260544).
- 3.18 The contractor shall install the ladder-type cable tray so protruding ends shall be closed with end caps or finishing clips.
- 3.19 Splices of horizontal runs shall be staggered at alternate runs.
- 3.20 The contractor shall support ladder-type cable tray within a minimum of 3 feet of a free end or as required to meet the working load detailed above.
- 3.21 Each end of the ladder-type cable tray shall be secured to structural members of the nearest video and data transport room G303 wall.
- 3.22 The contractor shall ensure ladder-type cable tray not be unsupported for more than six (6) feet.
- 3.23 The contractor shall ensure all bolts, nuts, and screws be tightened in accordance with manufacturer's recommendations.
- 3.24 The contractor shall ensure the protrusion of the threaded part of a threaded rod shall be no more than an amount equal to the diameter of the bolt, screw, or rod.

The length of the threaded part shall not be so short that more than one complete turn of the nut thread remains unengaged. Ends of bolts, screws, or threaded rods shall be free of sharp edges.

Fiber Optic Cable Management System

- 3.25 In Area A The contractor shall install fiber optic cable management system free from sharp burrs, edges or protrusions that could cause abrasion or laceration of the fiber cables within the VDTR room G303 as detailed in these specifications and as shown on the contract plans.
- 3.26 Fiber Optic Cable Management System shall be attached below to the Ladder-type Cable Tray and shall be supported by the Ladder-type Cable Tray on brackets designed specifically for supporting the Fiber Optic Cable Management System on the Ladder-type Cable Tray. Supporting brackets shall be positioned so not to limit vertical cable management drops into equipment racks.
- 3.27 The contractor shall install fiber optic cable management system above all equipment racks and at all intermediate crossings between equipment rack rows. The fiber optic cable management system shall be installed so that vertical cable management from the ladder cable tray at the rear and internally of each equipment rack does not interfere with fiber optic cable management system vertical and horizontal cable management. The contractor will coordinate installation of the fiber optic cable management system with the location of the equipment racks.
- 3.28 The contractor shall install fiber optic cable management system slots for vertical cable management drops to all equipment cabinets and in locations as directed by the engineer. Equipment cabinets C01 and C02 shall each have two slots and vertical cable management drops installed in locations as directed by the engineer.
- 3.29 The contractor shall install fiber optic cable management system slots and vertical cable management drops where the overhead cable ladder tray transitions under the access flooring into room G300 or as directed by the engineer. The fiber optic cable management vertical cable drops must be able to accommodate a minimum of 52 fiber optic 50/125um multimode patch cables. The contractor shall furnish and install air sealing grommets in access flooring to transition all fiber optic cables from the vertical fiber optic cable management system to under the access flooring.
- 3.30 The contractor shall close all protruding ends with end caps.
- 3.31 The contractor shall support the Fiber Optic Cable Management System at all bends and at 3 foot intervals on straight sections. The support brackets shall be installed between equipment racks so not to limit vertical cable drops.

Cable Trough Wire Basket System

- 3.32 In area A the contractor shall install cable trough wire basket system free from sharp burrs, edges or protrusions that could cause abrasion or laceration of data and fiber cables below the access flooring located in rooms G300, G301, G302, G318, G305, G306, G307, and G308 as shown on the contract plans or directed by the engineer. Refer to contract phasing plans for installation timeline.
- 3.33 In area B the contractor shall install cable trough wire basket system free from sharp burrs, edges or protrusions that could cause abrasion or laceration of data and fiber cables below the access flooring located in rooms G114 and G134 as shown on the contract plans or directed by the engineer. Refer to contract phasing plans for installation timeline.
- 3.34 The contractor shall properly fasten each section of wire basket system to the concrete floor. The wire basket system should be installed so not to interfere with electrical power cabling or plumbing and be centered under the access flooring panel.
- 3.35 The contractor shall properly ground each section of the wire basket system.
- 3.36 The contractor shall limit changes of the cable trough wire basket system in vertical height to one inch vertical per one foot of horizontal.
- 3.37 The contractor shall install cable drop outs to all applicable floor boxes and video walls as detailed in the plans or as directed by the engineer.
- 3.38 The contractor shall install a cable divider in the cable trough wire basket for fiber optic cabling from the VDTR room G303 wall penetration to all locations in rooms G300, G301, G302 and G318. Fiber optic cabling shall be installed in the cable trough wire basket on the side closest to the video display cubes located in rooms G300 and G301.
- 3.39 All cables installed in the cable trough wire basket shall be neatly bundled by cable type and secured to the wire basket.

Category 6A Patch Panels

- 3.40 In area A the contractor shall install 15 rack mounted category 6A patch panels in the VDTR room G303 equipment rack C03 for CAT6A cabling exiting the VDTR room and for two floor boxes located within the VDTR room. The patch panels shall be installed facing the front of the equipment rack on the front mounted rack rails. All patch panels shall be grouped together with no open rack spaces between each patch panel. Refer to contract phasing plans for installation timeline.

- 3.41 In area A the contractor shall install 28 rack mounted category 6A patch panels in the VDTR room G303 equipment rack C04 for CAT6A cabling terminating at equipment racks C5-C10, B1-B11, and A1-A11. The patch panels shall be installed facing the front of the equipment rack on the front mounted rack rails. All patch panels shall be grouped together with no open rack spaces between each patch panel. Refer to contract phasing plans for installation timeline.
- 3.42 In area A the contractor shall install a total of 28 rack mounted category 6A patch panels in the VDTR room G303 equipment racks C5-C10, B1-B11, and A1-A11. A patch panel shall be installed in each equipment rack facing the rear attached to the rear mounted rack rails. Refer to contract phasing plans for installation timeline.
- 3.43 In area B the contractor shall install 1 rack mounted category 6A patch panel in the A/V equipment rack located in storage closet room G134. The patch panel shall be installed in the equipment rack facing the front. The contractor shall coordinate installation of the patch panel with the Video and Graphics wall (item 1108745A) system installer. Refer to contract phasing plans for installation timeline.
- 3.44 The contractor shall install vertical cable management to properly secure and route cabling to each patch panel located within equipment racks C03 and C04.
- 3.45 The contractor shall terminate all CAT6A cabling to the category 6A patch panels.
- 3.46 The contractor shall label each CAT6A patch panel according to the approved labeling schema.

Modular Surface Mount Patch Panels

- 3.47 In Area A, the Contractor shall install modular surface mount patch panels with plug-in modules in locations listed below and as shown on the contract plans:
- The contractor shall install 2 modular surface mount patch panels in each highway operations console located in room G300 for a total of 16 patch panels.
 - The contractor shall install 2 modular surface mount patch panels in each storm operations console located in room G301 for a total of 8 patch panels
 - The contractor shall install 2 modular surface mount patch panels in each engineering cubicle located in room G305 for a total of 20 patch panels.
 - The contractor shall install 2 modular surface mount patch panels in each engineering office located in room G306 and G307 for a total of 4 patch panels.
 - The contractor shall install 2 modular surface mount patch panels in the collaboration area located in room G308.
- 3.48 The contractor shall coordinate the installation location of all modular surface

mount patch panels with the owner occupant. The contractor shall attach modular surface mount patch panels using approved fasteners to each location as listed above and as detailed on the contract plans.

- 3.49 The contractor shall terminate all CAT6A cabling to the modular surface mount patch panels.
- 3.50 Termination of the coaxial cable will be coordinated with the owner occupant contractor.
- 3.51 The contractor shall label each modular surface mounted patch panel according to the approved labeling schema.

Wall Mount and Floor Box Data Jacks

- 3.52 In Area A, the Contractor shall install floor box data plates with modular data jacks in locations listed below and as shown on the contract plans. Refer to contract phasing plans for installation timeline:
 - 1 floor box data plate (HOC13) located in Highway Operations Center Printer/Copier area (Room G300) for a total of 6 CAT6A modular jacks;
 - 1 floor box data plate (HOC16) located at the HOC Conference Room (Room G302) for a total of 6 CAT6A modular jacks;
 - 1 floor box data plate (ENG13) located in the Engineering Printer/Copier Area (Room G305) for a total of 6 CAT6A modular jacks;
 - 2 floor box data plates located in the VDTR (Room G303) for a total of 12 CAT6A modular jacks;
- 3.53 In Area A, the Contractor shall install surface mount wall plates with modular data jacks in locations listed below and as shown on the contract plans. Refer to contract phasing plans for installation timeline:
 - 1 wall mounted data plate (HOC18) located in Highway Operations Communications Closet (Room G318) for a total of 6 CAT6A modular jacks;
 - 1 wall mounted data plate (HOC14) located at the Highway Operations entrance for a total of 2 CAT6A modular jacks and 2 dual LC multimode fiber jacks;
 - 1 wall mounted data plate (HOC15) located at the HOC Conference Room (Room G302) for a total of 2 CAT6A modular jacks, 1 CAT6A shielded (HDBase-T) jack, 1 dual LC multimode fiber jack, and 2 BNC video jacks;
- 3.54 In Area B, the Contractor shall install floor box data plates with modular data jacks in locations listed below and as shown on the contract plans. Refer to contract phasing plans for installation timeline:

- 3 floor box data plates (TIM14, TIM09, and TIM05) located in the TIM area (Room G114) for a total of 18 CAT6A modular jacks. 1 floor box data plate shall be installed at each floor box location;
- 3.55 In Area B, the Contractor shall install surface mount wall or ceiling plates with modular data jacks in locations listed below and as shown on the contract plans. Refer to contract phasing plans for installation timeline:
- 2 wall mounted data plates (TIM06, TIM13) located in the TIM area (Room G114) for a total of 4 CAT6A modular jacks. 1 wall mounted data plate shall be installed at each wall location;
 - 1 ceiling mounted data plate (TIM10) located in the TIM area (Room G114) for a total of 2 CAT6A modular jacks;
- 3.56 The contractor shall secure all floor box data plates so they are flush inside the floor box. The contractor shall secure all wall mount data plates so they are flush with the finished wall. The contractor shall supply and install blank modular jacks for all unused positions in the floor box and wall mount data plates.
- 3.57 The contractor shall install and terminate all UTP CAT6A modular jacks. The contractor shall install all BNC modular jacks. All other modular jacks shall be installed and supplied by the video and graphics wall (Item 1108745A) installer.
- 3.58 The contractor shall ensure data plates can accommodate all needed modular jacks as detailed above and in the contract plans. The contractor shall coordinate with the video and graphics wall (Item 1108745A) installer to ensure wall mounted data plate sizes can accommodate A/V equipment modular jacks at locations HOC15 and HOC14.

4.0 Testing:

UTP CAT6A Cabling and Connectors

Testing of all horizontal and vertical CAT6A UTP cabling and connectors are to be tested to the communications specification and in accordance with the following:

- Category 6A Horizontal Cables: Perform a Category 6A channel test at 10GBASE-T 500Mhz for all Category 6A cables for continuity, shorts, opens, grounds, correct polarity, length, attenuation, NEXT, PSNEXT, ACR, PSACR, ELNEXT, PSELFEXT, resistance, return loss, propagation delay and delay skew. For 5% of all Category 6A cabling installed the contractor shall perform a Category 6A channel test at 10GBASE-T that includes PSANEXT and PSAFEXT tests.
- These tests shall establish that the cable installation from end-to-end (including any intermediate patch positions and termination devices) meets or exceeds the

manufacturer's claims in accordance with the cable and components which have been used.

- Any deficiencies found during testing must be corrected immediately and re-tested.
- Testing should be performed using a tester equipped with the most recent or latest version of EIA/TIA 568-B standard software. The tester shall be capable of testing all Category 6A cables for compliance with the 10GBASE-T standard at 328 feet.
- Testing will be considered completed once all records show that all installations meet 100% pass and have been certified by the manufacturer

Coaxial Cabling

Testing of all horizontal and vertical coaxial cabling are to be tested for continuity. Testing will be considered completed once all records show that all coaxial cables meet 100% pass.

Method of Measurement: This item will be paid for at the contract lump sum price for “Modify Existing Operations Center Control System” complete.

Basis of Payment: This item will be paid for at the contract lump sum price for “Modify Existing Operations Center Control System” which price shall include all administrative and procedural requirements, material, spare parts, equipment, warranties, testing, testing equipment, tools, labor, and work incidental thereto.

PAY ITEM

Modify Existing Operations Center Control System

PAY UNIT

LS

ITEM #1108745A - VIDEO AND GRAPHICS WALL EQUIPMENT

Description: The scope of this item is defined as follows:

Video and Graphics Wall Equipment: The scope includes the supply, delivery, installation, configuration, integration, and testing of 7 distinct VDA's:

- Highway Operations Center Operations Room G300: 11x3 Matrix of Display Cubes
- Area G301 Storm Center: 4x3 Matrix of Display Cubes
- Highway Operations Center Entrance Hallway: (2) 55" Flat Panel Displays
- Area G114 TIM Room: North 3x3 Matrix of Flat Panel Displays
- Area G114 TIM Room: South 3x3 Matrix of Flat Panel Displays
- Area G302 HOC Conference Room: (1) 84" Flat Panel Display
- Area G308 Engineering collaboration station (1) 55" Flat Panel Display

The video wall installation also includes the provision, installation, and configuration of 3 VDP's with associated software and accessories as detailed herein this specification. The VDP's will receive a variety of video inputs and will drive content for 6 of the 7 VDA's. The VDP's are intended to be a collaborative network-based video content distribution and management system for displaying content on the first 6 VDA's listed above.

The video wall installation also includes the provision and installation of all necessary cables, connectors, adapters, and cable management appurtenances starting from various video and data input sources to the VDP and outputs to the aforementioned VDA's.

The scope also includes the removal and disposal of the existing video and graphics wall equipment.

AV Equipment: The scope of work includes the supply, delivery, installation, configuration, integration, and testing of AV equipment and cabling in the following locations:

- Traffic Incident management (TIM) Room G114 and G134
- Highway Operations Center Conference Room G302 and G318
- Conference Rooms G117 and G118

Submittals: Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

1. Contractor Qualifications: The Contractor shall submit the Contractor Qualifications as the first stand-alone submittal. Until the Owner accepts these qualifications, no other submittals will be reviewed.
 - a. The Video Wall and AV Equipment Installer shall be an authorized equipment installer of the specified manufacturers with service facilities within 300 miles of the Project.
 - b. One of the Video Wall and AV Equipment Installer's employees working on the Project shall have a minimum of 5 years documented experience in successfully installing and commissioning projects of a similar size and complexity. References shall be provided of at least 3 projects of similar size and complexity within the last 5 years.
 - c. One of the Video Wall and AV Equipment installer's employees working on the Project shall be certified by the manufacturer to install and configure the following components:
 - Mitsubishi Display Cubes and flat panel displays
 - Jupiter Systems Catalyst Video Wall Processors and software
 - Crestron AV Room controllers
2. Product Data: For all materials including information regarding materials, finishes, and accessories.
3. Shop Drawings: Include functional block diagrams, wiring diagrams, and point-to point wiring details for the video wall and AV equipment, equipment rack front elevation drawings, and equipment installation drawings indicating supports and appurtenances required for proper installation.
4. Detailed Schedule of Work for each phase of the Project.
5. Operation and Maintenance Manuals: For video and graphics wall equipment to include in operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS. The Contractor shall provide all operation and maintenance manuals before the start of the 30 Day System Operational Test. Include the following:
 - Electronic As-built wiring diagrams and point to point wiring details for the video wall and AV equipment in Visio 2010 format.
 - Electronic Equipment cabinet front elevation drawings in Visio 2010 format.

- Electronic operations and maintenance manuals in PDF format along with two hard copy binders.

6. Warranties: Special warranties specified in this Section. The Contractor shall provide all warranties after the completion of the 30 Day System Operational Test.

Spare Parts: Before the end of the 30 Day System Operational Test, the Contractor shall furnish to the Engineer spare parts that match products installed that are packaged with protective covering for storage and identified with labels describing contents, as listed below:

- 2- Mitsubishi PN# 60HEF78 (Engine Only)
- 4-Thinklogical receiver cards PN# VEL-MITM03-LCRX
- 4-Thinklogical receiver cards PN# VQM-0H0003-LCTX
- 1-Thinklogical Rack mount chassis CHS-4 with dual power supplies
- 2- Mitsubishi PN# LM55P2 55" flat panel displays
- 2-DVI/HDMI Fiber Optic Extender Transmitters
- 2- DVI/HDMI Fiber Optic Extender Receivers
- 1-DVI/HDMI Fiber Optic Extender rack mount chassis with dual power supplies.
- Crestron DMPS3-4K-300-C
- Crestron DMPS3-4K-150-C
- 1-Crestron TSW-760
- 1-Barco ClickShare CSE-200
- 1-Jupiter 4500 series Power Supply, Solid State Drive, and Cooling Fan.
- 1-Jupiter 4000 series Power Supply, Solid State Drive, and Cooling Fan.

Warranty: Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information. All warranties shall commence on the date of the Engineer's acceptance after the successful completion of the 30 Day System Operational Test. The following equipment shall have 5 year manufacturer hardware and software warranties that can be serviced by any qualified installer:

- Jupiter Systems 4000 series processor
- Jupiter Systems 4500 series processor
- Jupiter Systems CRS4K series processor
- Jupiter Systems Canvas Clients and Server
- Mitsubishi PN# 60HEF78UA display cubes
- Mitsubishi PN# LM55P2 flat panel displays

Provide other warranties identified within this Section.

Definitions: The following technical acronyms or terms are used throughout this specification. The Contractor may refer to this table for the description of the acronym or term.

Term	Description
AC	Alternating Current
AV	Audio Visual
CATV	Cable Television
CCTV	Closed-circuit Television
DC	Direct Current
VDP	Video Display Processor
DLP	Digital Light Processing
DVI	Digital Visual Interface
HD	High Definition
HDD	Hard Disk Drive
HDMI	High-Definition Multimedia Interface
HDCP	High-Bandwidth Digital Content Protection
HOC	Highway Operations Center
LAN	Local Area Network
LCD	Liquid Crystal Display
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
ITS	Intelligent Transportation System
KVM	Keyboard-Video-Mouse
POE	Power-over-Ethernet
PTZ	Pan-tilt-zoom
RAID	Redundant Array of Independent Disks
RCA	Radio Corporation of America
SDI	Serial Digital Interface
SDK	Software Development Kit
SIP	Session Initiation Protocol
SFP/SFP+	Small Form-factor Pluggable / Enhanced Small Form-factor Pluggable
SSH	Secure Shell
SVGA	Super Video Graphics Array
UI	User Interface
USB	Universal Serial Bus
VDA	Video Display Assembly
VDC	Video Display Cube
VDP	Video Display Processor
VGA	Video Graphic Array
VMS	Video Management System
VNC	Virtual Network Computing

Delivery, Storage, and Handling:

- All materials shall be delivered in the manufacturer's original and undamaged protective packages.
- All materials shall be stored in their original protective packaging and protected against soiling, physical damage, or wetting, before and during installation.
- All equipment shall be protected during transportation and installation against damage and stains.
- Store materials and equipment in a clean, dry location free from construction dust, precipitation and excess moisture. It shall be the Contractor's responsibility to secure and protect the equipment and material stored in this area.
- Replace damaged materials and equipment, as determined by the Engineer, at no additional cost to the Department.

Materials:

2.01 Video Display Cubes

- A. The Contractor shall furnish 45 Mitsubishi PN# 60HEF78UA front access DLP™ rear-projection cubes with a replaceable internal LED engine. Each DLP™ display cube shall measure 60 inches in diagonal. Each VDC shall include a ThinkLogical fiber receiver card PN# VEL-MITM03 with SFP optics rated for a minimum 3280 feet over 50/125um OM4 multimode fiber.
- B. The Contractor shall furnish Twenty-three rack mounted DVI to fiber transmitter cards manufactured by ThinkLogical, model# VQM-0H0003-LCTX with SFP optics rated for a minimum 3280 feet over 50/125um OM4 multimode fiber. The ThinkLogical transmitter cards shall be housed in a rack mounted chassis Model# CHS-4 that can house a minimum of four transmitters. The rack mounted chassis shall have dual redundant power supplies. The twenty-three dual transmitter cards shall be capable of driving 45 individual displays. The Contractor shall provide the number of rack mount chassis necessary to accommodate all required ThinkLogical DVI to fiber transmitter cards.
- C. The Contractor shall furnish six Mitsubishi motorized adjustment tools for doing picture alignment.
- D. The video display cube manufacturer shall have a minimum of five years' experience in the design, manufacture, and testing of video wall projection systems.
- E. The video display cubes shall have internal sensors for red, green and blue for auto color and brightness balancing. Automatic color and brightness circuits shall be built into the cube that does not require external software and computer input for adjustment.
- F. The video display cube shall have an Ethernet port for service and firmware upgrades.

- G. The video display cube shall have both an input and output control port to allow uniform color and brightness across the entire display assembly.
- H. The video display cubes displays shall be rated to operate on a twenty-four (24) hour, seven (7) day per week basis without degradation in performance and operation.
- I. The Contractor shall supply two steel support frames that shall meet the height, width, depth and weight requirements for the 33 cube system and 12 cube systems. The frame shall include adjustable “feet” to level the cubes. The frame shall be completely compatible with the approved video wall cube products, and shall be furnished or approved by the video wall manufacturer. The frame shall be modular. The modular unit shall be fastened as a single unit in place with all hardware included. The frame shall be black in color. The approximate cube sill height shall be 48” from the top of the raised floor.
- J. The Contractor shall supply black front face acoustic panels and metal support brackets to secure the front face acoustic panels.
- K. Video Cubes shall be capable of being turned on or off, wired and wireless, individually or collectively, by Remote Control. The contractor shall furnish 3 remote controls.
- L. Each video cube shall have noise level not greater than 35 dBs
- M. Each video display cube assembly shall include an unmanaged switch for connecting each VDA for management from a single point.

N. DLP Video Display Cube System Requirements shall meet or exceed the following:

Screen Display Technology	DLP™, 1 – DMD chip per cube with LED light source
Screen Display Resolution	1920 x 1080 pixels
Screen Size	60" diagonal viewable
External Cube size	Maximum 52.6" W x 39.7" H x 34.9" D
Cooling Fans	100,000 hour service life expectancy
Cube Weight	Maximum 214 lbs. per cube
Cube Displacement/mullion	Maximum displacement/mullion between cubes 1.0mm – 2.0mm
Full Viewing Angle	178° Horizontal, 60° Vertical
Light Output	Minimum 1000 ANSI lumens
Light Output/Brightness	Maximum 1160 cd/m2 Minimum 170 cd/m2
Brightness Uniformity	95% at 90% image height
Color Uniformity	Automated color balancing between cubes
Cube Picture Alignment	Motorized adjustment tools or manual alignment
Dimming Uniformity	Automated dimming control at cube screen edge
Contrast Ratio	Minimum 1500:1
Power consumption	Maximum 258Watts Minimum 96Watts
Power	AC 100 – 240V ±10%, 50/60 Hz
Operating Humidity	20% to 80% Non-Condensing
Storage Humidity	20% to 80% Non-Condensing
Operating Temperature	Minimum 50°F, Maximum 86°F
Storage Temperature	Minimum -4°F, Maximum 122°F
Light Source	80,000 hours typical
Cube Access	Front accessible
Cube Input Connection	50/125um multimode fiber
Safety	UL Listed, FCC Listed
Remote Control	Wireless and wired use- individual /all control

2.02 Flat Panel Displays, 55"

- A. The Contractor shall furnish 21 Mitsubishi PN # LM55P2 low-bezel active matrixes TFT flat panel LCD displays with LED backlight. The panels shall measure 55 inches diagonal and include 1 front access wall mount bracket for each display.
- B. Each LCD flat panel display shall use wall mounting brackets allowing front-access for maintenance activities intended for video wall applications. The wall mounting brackets shall be Chief Connexsys, Mitsubishi BR-LM1KK, or an approved equal.
- C. Each LCD flat panel display shall be VESA wall mountable and shall be provided with mounting hardware appropriate for the display's weight and dimensions.

- D. The LCD flat panel manufacturer shall have a minimum of five (5) years' experience in the design, manufacture, and testing of video wall projection systems.
- E. The LCD flat panel shall have internal sensors for red, green and blue for auto color and brightness balancing. Automatic color and brightness circuits shall be built into the cube that does not require external software and computer input for adjustment.
- F. The LCD flat panel shall have both an input and output control port to allow uniform color and brightness across the entire display assembly.
- G. The LCD flat panel displays shall be rated to operate on a twenty-four (24) hour, seven (7) day per week basis without degradation in performance and operation.
- H. The maximum total bezel width between any two LCD flat panel displays in a VDA shall be 5mm or less including gaps between displays.
- I. Removable acoustic panels shall be provided to fill the gaps between the LCD flat panel displays and the gypsum walls.
- J. LCD Video Display Units Requirements shall meet or exceed the following:

Screen Display Technology	Active Matrix TFT LCD with Direct LED backlight
Screen Display Resolution	1920x1080 or higher
Screen Size	55" diagonal viewable
Display Aspect Ratio	16:9
Full Viewing Angle	Minimum 178° Horizontal, 178° Vertical
Light Output/Brightness	Maximum 700 cd/m2
Displayable Colors	Minimum 16.7 million
Contrast Ratio	Minimum 4000:1
Refresh Rate	Minimum 60 Hz
Power	AC 100 – 240V ±10%, 50/60 Hz
Operating Humidity	20% to 80% Non-Condensing
Storage Humidity	20% to 80% Non-Condensing
Operating Temperature	Minimum 41°F, Maximum 95°F
Storage Temperature	Minimum -20°F, Maximum 140°F
Light Source Life Expectancy	Minimum 50,000 hours rated for 24/7 365 operation
Response Time	<8ms (Gray to Gray)
Input/output Terminals	DisplayPort 1.2a (in/out), DVI-D (in/out), HDMI (in), Video (in) BNC type, RS232 control port (in/out), Intel OPS slot, LAN control port.
Safety	UL Listed, FCC Listed
Remote Control	Wireless and wired use- individual /all control
Power consumption	240W Max
Weight	72lbs
Manufacturer Warranty	3 years parts and labor
Anti-Glare	Panel surface to have anti-glare treatment

2.03 Flat Panel Display, 84"

- A. The Contractor shall furnish one 84" LED backlit flat panel display. The panel shall measure 84 inches diagonal and include the necessary wall mount bracket.

- B. Each LCD flat panel display shall be VESA wall mountable and shall be provided with wall mounting hardware appropriate for the display’s weight and dimensions.
- C. The 84” LCD flat panel display wall mounting bracket shall have a minimum adjustable tilt of 10 degrees. The wall mounting bracket shall be black in color. The wall mounting bracket shall come with a minimum five year manufacturer warranty.
- D. The LCD flat panel manufacturer shall have a minimum of five (5) years’ experience in the design, manufacture, and testing of LCD flat panels.
- E. The LCD flat panel display shall be rated to operate on a twenty-four (24) hour, seven (7) day per week basis without degradation in performance and operation.
- F. LCD Video Display Units Requirements shall meet or exceed the following:

Screen Display Technology	S-IPS LCD with Edge LED backlight
Screen Display Resolution	3840x2160, 1920x1200, 1920x1080
Screen Size	84” diagonal viewable
Display Aspect Ratio	16:9
Full Viewing Angle	Minimum 178° Horizontal, 178° Vertical
Light Output/Brightness	Maximum 500 cd/m2
Displayable Colors	Minimum 1.07 Billion
Contrast Ratio	Minimum 1400:1
Refresh Rate	Minimum 60 Hz
Power	AC 100 – 240V ±10%, 50/60 Hz
Operating Humidity	20% to 80% Non-Condensing
Storage Humidity	20% to 80% Non-Condensing
Operating Temperature	Minimum 41°F, Maximum 95°F
Storage Temperature	Minimum -20°F, Maximum 140°F
Light Source Life Expectancy	Minimum 50,000 hours rated for 24/7 365 operation
Response Time	<12ms (Gray to Gray)
Input/output Terminals	DisplayPort 1.2 (in), HDbase-T (in), DVI-D (in), 3-HDMI (in), RS232 control port (in), Intel OPS slot, LAN control port.
Safety	UL Listed, FCC Listed
Remote Control	Wireless and wired use- individual /all control
Power consumption	400W Max
Weight	175lbs or less
Manufacturer Warranty	3 years parts and labor
Anti-Glare	Panel surface to have anti-glare treatment

2.04 Video Display Processors

- A. The VDP for the highway operations center 11x3 matrix and storm room 4x3 matrix video display cubes furnished by the contractor shall be a Jupiter Systems Fusion Catalyst 4000 series VDP model #FC4000-43HC-16DVI-13QDEC-3SSD-RAID1-2ETH-64GB or latest equivalent version.
- B. The VDP for the TIM room North and South 3x3 matrix of flat panel displays furnished by the contractor shall be a Jupiter systems Fusion Catalyst 4500 series VDP model #FC4500C-18HC-12DVIh-12QDEC-3SSD-RAID1-2NIC-48RAM or latest equivalent version.

- C. The VDP for the two flat panel displays at the highway operations center entrance hall and the 84” flat panel display in highway operations conference room G302 furnished by the contractor shall be a Jupiter Systems model CRS-4K or latest equivalent version.
- D. The VDP’s shall include the following Canvas system software components furnished by the contractor:
- 8 Canvas clients with named licenses
 - 14 Canvas clients with floating licenses
 - 2 Canvas server licenses
- E. The VDP’s shall be able to input, manage, and distribute visual content, including digital H.264 CCTV video, web pages, CATV, workstation applications, and active screens from networked workstations using the same Canvas system software.
- F. The VDP shall be able to decode, manage, and display multicast H.264 digital streaming video.
- G. The 4000 series and 4500 series VDP’s shall include both video DVI input cards and video Decoder input cards.
- H. The 4000/4500 series VDP shall have the control inputs that can be interfaced by third party vendors.
- I. The 4000/4500 series VDP canvas software shall have the ability to create multiple spaces for different users to control display content. These display areas cannot cross over into another. Users not belonging to a particular display area of the video wall shall not be entitled to change layouts and sources.
- J. The VDP canvas software shall be able to stretch, re-position, and resize any video source on any VDA.
- K. The VDP canvas software shall be accessible on any networked workstation connected to the ITS LAN in the HOC.
- L. The VDP canvas software shall be able to create and edit user groups. The canvas software shall manage permissions for users and user groups across all VDP’s. At a minimum the definable permissions shall include UI function rights, viewing access rights, source list access rights, and display access rights.
- M. The VDP canvas software shall include an administrator role that shall be able to manage system configuration, sources, user groups, and user authentication.
- N. The VDP’s shall be able to display a minimum of one hundred and twelve (112) independent visual sources simultaneously in any combination on the totality of all VDAs. The sources shall range from 4CIF resolution to 1080p.
- O. The VDP canvas software shall be able to create and add borders and text overlays to individual video content sources. The borders and text overlays shall have selectable options for color, widths, and text size.

- P. Visual content from networked H.264 sources shall be transmitted and displayed with no pixel loss or degradation.
- Q. The VDP canvas client and server software shall run on a Microsoft-based operating system.
- R. The VDP canvas software shall be configured such that each server supplied has a dedicated function. For example, the server driving content to the display wall cannot be the same server managing administrative functions. The canvas server software will be loaded onto highway operations existing virtual server environment
- S. The VDP shall include a rack mounted slide out Keyboard, mouse, and LCD monitor.
- T. The hardware requirements for the 4000/4500 series VDP shall meet or exceed the following specifications:

4000 Series CPU	Dual Quad Core Xeon 2.0Ghz or better
4500 Series CPU	Dual Six Core Xeon E5 2.4Ghz or better
4000 Series Memory	Minimum 64GB memory, ECC DDR-2 SDRAM
4500 Series Memory	Minimum 48GB memory, ECC DDR-3 SDRAM
Hard Disk System	Three 512GB Solid State Drives configured as RAID 1 with hot spare.
Optical Drive	One DVD-RW/CD-RW drive
Ethernet ports	Two 10/100/1000 Ethernet ports
Serial Communication	Minimum One RS-232 port
USB ports	Minimum Four USB 2.0 ports
4000 Series Chassis	4U rack mount/hot swap fans and power supplies
4500 Series Chassis	3U rack mount/hot swap fans and power supplies
4500 Expansion Chassis	3U rack mount/hot swap fan and redundant power supplies
Power	AC 100 – 240V ±10%, 50/60 Hz
4000 series DVI outputs	48 DVI-D 1920x1080 resolution 60Hz outputs
4500 series DVI outputs	20 DVI-D 1920x1080 resolution 60Hz outputs
4000 series Stream inputs	52 SD/HD H.264 video streams up to 1080p/30
4500 series Stream inputs	48 SD/HD H.264 video streams up to 1080p/30
4000 series DVI inputs	16 DVI inputs compatible with DL-DVI max resolution 2560x1600, SL-DVI/VGA max resolution 2048x1200, and YPrPb progressive.
4500 series DVI inputs	12 HDCP DVI inputs compatible with DL-DVI max resolution 2560x1600, SL-DVI/VGA max resolution 2048x1200, and YPrPb progressive.
Operating System	Latest Microsoft Windows 10 LTSC Professional Operating System.
Video Wall Control Software	Canvas Client, remote KVM software (VNC)
Manufacturer Hardware Warranty	2 years parts and labor

2.05 Digital KVM Extender

- A. The Contractor shall furnish 6 digital KVM extenders.
- B. The digital KVM extender shall be the Adderlink 2112T infinity VNC extender.
- C. The digital KVM extender shall be capable of being remotely accessed from the VDP canvas client over the ITS network using VNC viewer.
- D. The digital KVM extender shall be fully compatible with the VDP.

- E. The digital KVM extender shall allow 16 simultaneous connections for viewing and control using the VNC client software.
- F. The digital KVM extender shall include 1U rack mount kits that can house two units in a 19 inch equipment rack. The unit will either be rack mounted or shelf mounted.
- G. The digital KVM extender shall be fanless with no moving parts.
- H. The hardware requirements for the digital KVM extender shall meet or exceed the following specifications:

Ethernet ports	One 10/100/1000 Ethernet port for VNC access
Audio inputs/outputs	1-3.5mm input and 1-3.5mm output
USB ports	USB 2.0
Chassis	1U rack mount
Power	AC 100 – 240V ±10%, 50/60 Hz
DVI inputs	2 DVI-D inputs compatible with DL-DVI max resolution 2560x1600 or SL-DVI max resolution 1920x1200
Manufacturer Warranty	Minimum 1 years parts and labor

2.06 H.264 Video Encoder

- A. 12 digital H.264 video encoders shall be furnished by the Contractor.
- B. The H.264 Video Encoder shall be the Matrox MaeveX MVX-E5150F.
- C. The H.264 video encoder shall be accessed remotely from the VDP canvas client via IP to the dedicated Quad HD decoder input card.
- D. The H.264 video encoder shall be fully compatible with the VDP.
- E. The H.264 video encoder latency shall be 150ms or less.
- F. The H.264 video encoder shall include 1U rack mount kits that can house two units in a 19 inch equipment rack. The unit will either be rack mounted or shelf mounted.
- G. The H.264 video encoder shall be fanless with no moving parts.
- H. The hardware requirements for the digital H.264 video encoder shall meet or exceed the following specifications:

Ethernet Ports	One 100/1000 Ethernet port
Audio Inputs/Outputs	1-3.5mm input and 1-3.5mm output
Chassis	1U rack mount
Power	AC 100 – 240V ±10%, 50/60 Hz
DVI/HDMI Inputs	1-HDMI input with L-PCM audio max resolution 1920x1080p60 or DVI via DVI-to-HDMI adapter
DVI/HDMI/VGA Outputs	1-HDMI output with L-PCM audio (pass-through), or DVI via DVI-to-HDMI adapter (pass-through)
Video Encoder	H.264 part 10 up to 1920x1080p60 and 1920x1200(56Hz)
Encoder Bitrates	Adjustable from 100Kbps to 25Mbps
Encoder Rate Control	Constant bit rate, variable bit rate, adjustable GOP size.
Audio Encoder	MPEG4 AAC-LC 2 channel (stereo)
Audio Sample Frequency	32, 44.1, and 48kHz
Audio bitrate	96, 128, 192, and 256Kbps
Network Protocols	RTSP/RTP/RTCP over UDP
Network Stream Type	Unicast, Multicast, and Multi Unicast
Manufacturer Warranty	Minimum 1 year parts and labor

2.07 DVI/HDMI Fiber Optic Extender

- A. The 21 rack mounted HDMI/DVI fiber optic transmitters furnished by the contractor shall be Extron Electronics Powercage FOX Tx HDMI MM with SFP optics rated for a minimum 6561 feet over 50/125um multimode OM4 fiber. The 21 wall or screen mounted HDMI/DVI fiber optic receivers furnished by the contractor shall be Extron Electronics Foxbox Rx HDMI MM with SFP optic rated for a minimum 6561 feet over 50/125um multimode OM4 fiber.
- B. The one rack mounted HDMI fiber optic receiver furnished by the contractor shall be Extron Electronics Powercage FOX Rx HDMI MM with SFP optic rated for a minimum 6561 feet over 50/125um multimode OM4 fiber. The one shelf mounted HDMI fiber optic transmitter furnished by the contractor shall be Extron Electronics Foxbox Tx HDMI MM.
- C. The DVI/HDMI fiber optic extenders shall extend video, audio, and RS-232 control signals over 50/125um OM4 multimode fiber.
- D. The DVI/HDMI fiber optic extenders shall have real-time status LED indicators for troubleshooting and monitoring.
- E. The rack mounted DVI/HDMI fiber optic extenders shall use a chassis with dual redundant power supplies. The Contractor shall provide the number of rack mount chassis' necessary to accommodate amount of DVI/HDMI fiber optic extenders supplied.
- F. The DVI/HDMI fiber optic extenders shall have a built in EDID Minder to automatically manage communication between connected devices.
- G. The DVI/HDMI fiber optic extenders shall be HDCP compliant and include a key minder to continuously verify compliance.

H. The hardware requirements for the DVI/HDMI fiber optic extenders shall meet or exceed the following specifications:

Fiber Ports	2 bidirectional LC connectors
Audio Ports	1-3.5mm stereo input and 1-3.5mm output
Chassis	Rack mount or shelf mount
Power	AC 100 – 240V ±10%, 50/60 Hz
Operating temperature	Minimum 32°F, Maximum 122°F
DVI/HDMI extender Transmitter Inputs/Receiver Outputs	1-HDMI HDCP compliant input with L-PCM audio max resolution 2048x1080p60 or DVI via DVI-to-HDMI adapter
DVI/HDMI extender Receiver Inputs/Transmitter Outputs	1-bidirectional 2km multimode fiber at 850nm
Optical loss budget	7 dB or greater over 50/125um multimode fiber
Channel data rate	4.25 Gbps or greater
Audio Gain	Adjustable, -18 dB to +10 dB
Audio Frequency Response	20 Hz to 20kHz
Audio Sample Frequency	48kHz
Audio bits per sample	18 bits per channel
Control Port	1-RS-232
Control Port Baud Rate	9600 to 115,200 baud
Manufacturer Warranty	Minimum 3 year parts and labor

2.08 Over The Air (OTA) Tuner

- A. The Contractor shall furnish and install 1 stand-alone over the air HDTV/cable TV tuner with VGA and HDMI outputs. The tuner shall be able tune ATSC, NTSC, and QAM HDTV channels. The tuner shall be rack mountable.
- B. The tuner shall decode MPEG-4 and MPEG-2 OTA channels and scale video outputs from 480p to 1080p.
- C. The tuner shall have an RS-232 and IR input control ports.
- D. The tuner shall have an F type coax connector for antenna input.
- E. The OTA tuner shall be the Contemporary Research 232-ATSC 4 HDTV Tuner.

2.09 RF receiver and Universal remote control

- A. The Contractor shall furnish 3 RF receivers and universal remote controls. The Contractor shall furnish 6 IR emitters to control 3 cable tuners and 1 OTA tuner. The system shall have the ability to control any cable tuner from any of the 3 locations.
- B. The RF receiver and universal remote control shall support a minimum of 40 devices including but not limited to HD cable TV tuner and OTA tuner.
- C. The RF receiver and universal remote control shall be a single system for all three areas within the highway operations center. The system shall have programmable outputs so remote IR commands are only sent to specific CATV tuners. The system shall not broadcast IR commands to all CATV tuners simultaneously.

- D. The RF receiver and universal remote control must have macro programmability.
- E. The RF receiver and universal remote control shall be programmable using PC based software.
- F. The RF receiver and Universal remote control shall be Compete Control MX-900.

2.10 EDID Minder

- A. The Contractor shall furnish 15 EDID minders for enterprise and ITS PC's connected to the VDP DVI inputs. The EDID minder shall prevent PC computers from deactivating inactive DVI ports when connected directly to the VDP.
- B. The EDID minder shall support resolutions up to 1920x1200, 2K, or 1080p
- C. The EDID minder shall be HDCP compliant.
- D. The EDID minder shall store EDID information from DVI displays and shall not require power except for initial programming.
- E. The EDID minder shall be Gefen DVI detective Plus.

2.11 Cables and Connectors

- A. Fiber Optic Patch Cables and modular wall jacks
 - Multimode fiber optic patch cables shall be tight buffered 50/125um OM4 rated for bandwidths up to 100Gb/s transmission.
 - Multimode fiber optic patch cables and modular wall jacks shall have LC type connectors and have a ceramic ferrule
 - Multimode fiber optic patch cables shall be plenum rated and have an operating temperature of rating of -40F to 185F.
 - Data cables that pass through floor box locations shall have 8 foot coils to accommodate potential future room configuration changes.
- B. DVI Cables
 - The DVI cable shall support a minimum resolution of 1080p/60.
 - The DVI cable shall support 24 bit color depth.

- The DVI cable shall have 28 AWG minimum copper wire size.
- The DVI cable shall be plenum rated when installed above the ceiling or below the floor.
- Data cables that pass through floor box locations shall have 8 foot coils to accommodate potential future room configuration changes.

C. HDMI Cables

- The HDMI cable shall support a minimum resolution of 4K/60.
- The HDMI cables shall be version 2.0 or newer and support HDCP version 2.2 or newer.
- The HDMI cable shall be plenum rated when installed above the ceiling or below the floor.
- Data cables that pass through floor box locations shall have 8 foot coils to accommodate potential future room configuration changes.

D. UTP Category 6A patch cables

- Category 6A UTP patch cables shall be unshielded twisted pair cable suitable for 10GBase-T local area network applications. The outer jacket color shall be blue.
- The Category 6A cable shall be used for Ethernet and serial data communications between equipment.
- Data cables that pass through floor box locations shall have 8 foot coils to accommodate potential future room configuration changes.
- Category 6A cables shall be plenum rated when installed above the ceiling or below the floor.

E. The Contractor shall furnish and install all necessary cables and connectors needed to have a complete working video and graphics wall. All cables shall be plenum rated when installed above the ceiling or below the floor.

2.12 Audio Visual Room Controllers

A. The contractor shall furnish 1 AV room controller for room G114. The TIM room AV room controller shall be a Crestron DMPS3-4K-300-C or newest equivalent model.

- The AV room controller shall include the control system, matrix switcher, video scalers, mic mixer, audio digital signal processor (DSP), and amplifier all in a single rackmount chassis.
- The AV room controller shall include a five port unmanaged POE Ethernet switch for connecting and powering a minimum of three Crestron touch panel screens.
- The AV room controller shall include two DM8G+ HDBase-T transmitters. The transmitters shall be Crestron DM-TX-4K-302-C or newest equivalent and compatible model.
- The AV room controller shall include one Crestron line amplifier. The line amplifiers shall be manufactured by Crestron and shall output 70 or 100 volts. The line amplifier shall be sufficient in wattage to power eight Crestron ceiling speakers.
- The AV room controller shall include eight ceiling mounted Crestron Saros IC6T speakers with grills. The ceiling speakers shall include drop ceiling mounting hardware and safety strap cables. The ceiling speakers shall be rated for in ceiling plenum installations.
- The AV room controller shall include three Crestron touch panel screens. The touch panel screens shall be Crestron TSW-760 or newest equivalent and compatible model.
- The hardware requirements for the Crestron DMPS3-4K-300-C shall meet or exceed the following specifications:

Operating System	Crestron 3-series
Video Switcher	8x4 matrix
Video Scaler	2-4K video scalers
Audio Switcher	13x5 stereo matrix switcher
Mic Mixer	6 microphone input channels with DSP
Amplifier	1 channel 40 watts RMS @ 70 or 100 Volts 2 channel 20 watts RMS @ 8 Ohms
Chassis	Rack mount 3U chassis
Power	AC 100 – 240V ±10%, 50/60 Hz
Operating temperature	Minimum 41°F, Maximum 104°F
Video Inputs	6-HDMI (DVI/DisplayPort compatible) 2-DM 8G+, HDBase-T compliant
Video Outputs	2-HDMI (DVI compatible) 2-DM 8G+, HDBase-T compliant
LAN Ethernet	1-10/100/1000 Mbps RJ-45
Control Subnet	1-10/100/1000 Mbps RJ-45
Audio inputs	5-terminal block balanced/unbalanced stereo analog line level inputs.
Audio Frequency Response	20 Hz to 20kHz
Audio Sample Frequency	48kHz
Control Port	2-RS-232 Bidirectional ports
Control Port Baud Rate	9600 to 115,200 baud
Manufacturer Warranty	Minimum 3 year parts and labor

B. The contractor shall furnish 3 room controllers for installation in rooms G117, G118, and G302. The conference room AV room controllers shall be Crestron DMPS3-4K-150-C or newest equivalent model.

- The AV room controller shall include the control system, matrix switcher, video scalers, mic preamp, and audio digital signal processor (DSP) all in a single rackmount chassis.
- Each AV room controller shall include a minimum five port POE Ethernet switch for connecting and powering a minimum of two Crestron touch panel control screens.
- Each AV room controller shall include two Crestron touch panel screens. The touch panel screens shall be Crestron TSW-760 or newest equivalent and compatible model.
- Each AV room controller shall include one Crestron line amplifier. The line amplifiers shall be manufactured by Crestron and shall output 70 or 100 volts to each speaker. The line amplifier shall be sufficient in wattage to power four Crestron ceiling speakers in each conference room.
- Each AV room controller shall include four ceiling mounted Crestron Saros IC6T speakers with grills. The ceiling speakers shall include drop ceiling mounting hardware and safety strap cables. The ceiling speakers shall be rated for in ceiling plenum installations.
- The hardware requirements for the Crestron DMPS3-4K-150-C shall meet or exceed the following specifications:

Operating System	Crestron 3-series
Video Switcher	6x1 matrix
Video Scaler	4K video scalers
Audio Switcher	6x1 stereo matrix switcher
Mic Mixer	1 microphone input channel with DSP
Chassis	Rack mount 1U chassis
Power	AC 100 – 240V ±10%, 50/60 Hz
Operating temperature	Minimum 41°F, Maximum 104°F
Video Inputs	4-HDMI (DVI/DisplayPort compatible) 2-DM 8G+, HDBase-T compliant
Video Outputs	1-HDMI (DVI compatible) 1-DM 8G+, HDBase-T compliant
LAN Ethernet	1-10/100 Mbps RJ-45
Control Subnet	1-10/100/1000 Mbps RJ-45
Audio Inputs	4-3.5mm unbalanced stereo analog line level inputs.
Audio Outputs	1-5 pin 3.5mm balanced/unbalanced stereo line level outputs
Audio Frequency Response	20 Hz to 20kHz
Audio Sample Frequency	48kHz
Control Port	1-RS-232 Bidirectional ports
Control Port Baud Rate	9600 to 115,200 baud
Manufacturer Warranty	Minimum 3 year parts and labor

2.13 Wireless presentation

- A. The contractor shall furnish 5 wireless presentation systems for installation in rooms G114, G117, G118, G302, and G308.
- B. The wireless presentation systems shall be Barco ClickShare CSE-200 or newest equivalent model.
- C. The wireless presentation system shall have externally mounted wireless antennas.
- D. The Barco ClickShare shall support viewing two simultaneous screens
- E. The hardware requirements for the Barco ClickShare CSE-200 shall meet or exceed the following specifications:

Operating System support	Windows 7/8/8.1/10 Mac OSX 10.10/10.11/10.12 Android v5/v6/v7 via ClickShare application iOS 8/9/10 via ClickShare application
Video Outputs	1-HDMI
Output resolution	1920x1200
Noise level	Fanless
Chassis	Surface mount
Power	AC 100 – 240V ±10%, 50/60 Hz
Operating temperature	Minimum 32°F, Maximum 104°F
Audio Inputs	1-HDMI or 1-3.5mm
LAN Ethernet	1-10/100 Mbps RJ-45
Wireless Frequency Band	2.4GHz and 5 GHz
Wireless transmission	IEEE 802.11 a/g/n
Manufacturer Warranty	Minimum 3 year parts and labor

2.14 Laser Projector

- A. The contractor shall furnish 2 laser projectors for installation in rooms G117 and G118.
- B. The laser projector shall use a solid state laser phosphor technology for illumination.
- C. The laser projector manufacturer shall have a minimum of 5 years’ experience in the design, manufacture, and testing of laser projection systems.
- D. The laser projector shall be rated to operate on a 24 hour, 7 day per week basis without degradation in performance and operation.
- E. The laser projector shall include an HDBase-T connection.

- F. The laser projector shall include the ceiling mounting hardware and safety strap.
- G. The laser projector shall have an Intel OPS slot.
- H. The laser projector shall include the proper lens for projecting the image onto the wall.
- I. The laser projector shall meet or exceed the following specifications:

Laser Projector Illumination Technology	Laser Phosphor Illumination
Screen Display Resolution	4096x2160 maximum with native resolution of 1920x1200
Projection Screen Size	60" to 250" diagonal minimum
Display Aspect Ratio	16:10
Lamp Life	20,000 hours or greater
Display technology	.67" DMD or larger
Light Output	8000 lumens or greater
Contrast Ratio	Minimum 10000:1 dynamic
Scan Rates	Minimum horizontal 15kHz to 91kHz Minimum vertical 24Hz to 85Hz
Power	AC 100 – 240V ±10%, 50/60 Hz
Operating Humidity	20% to 80% Non-Condensing
Operating Temperature	Minimum 32°F, Maximum 104°F
Input/Output Terminals	1-DisplayPort (in), 1-HDbase-T (in), 1-HDMI (in), 1-HDMI (out), RS232 control port (in), Intel OPS slot, LAN control port.
Safety	UL Listed, FCC Listed
Remote Control	Wireless and wired use- individual /all control
Power consumption	875W Max
Weight	62lbs or less
Manufacturer Warranty	3 years parts and labor

2.15 Wireless Microphone System

- A. The contractor shall furnish 1 wireless microphone system for installation in room G134 and G114.
- B. The wireless microphone system shall be Shure SLX4 or newest equivalent model. The wireless microphone system shall include four Shure SM58 wireless microphones.
- C. The Shure SLX4 shall be capable of supporting up to four wireless microphones.
- D. The wireless microphone system shall have both balanced and unbalanced microphone outputs.

2.16 Podium

- A. The contractor shall furnish 3 podiums for installation in rooms G117, G118, and G114.
- B. The Podium shall be Marshall MRTA-32 system lectern.

- C. The podium finish shall be classic mahogany.
- D. The overall dimensions of the podium shall be 33”W x 45”H x 31”D
- E. The podium shall include fixed rack rails, heavy duty drop leaf, halogen light, cooling fan, and medium cable reservoirs with AC outlets.
- F. The podium shall include an XLR connection for a wired microphone.

2.17 HDBase-T Cables

- A. The contractor shall furnish HDBase-T cabling, and modular jacks for rooms G114, G117, G134, G318, G118, and G302.
- B. Data Cables shall be TIA/EIA 568B Category 6A, characterized to a minimum 500 MHz, suitable for 10GBase-T local area network applications up to 328 feet. The shielded twisted pair cabling shall use matched components from a single manufacturer and the cabling system shall be certified to deliver system performance over the lifetime of the application for which the cabling system was originally designed to support.
- C. All HDBase-T cables shall be plenum rated.
- D. HDBase-T cables shall use 8 pin category 6A shielded RJ-45 connectors.
- E. The HDBase-T cables shall be compatible with the Crestron room controllers, Crestron transmitters, 84” LCD flat panel display, and Laser projectors.
- F. The HDBase-T cables shall be designed to handle 4K/60 video content without degradation.

2.18 Speaker Cables

- A. The contractor shall furnish speaker cables for all in ceiling speakers installed in Rooms G114, G117, G118, and G302.
- B. Speaker Cables shall meet or exceed the following requirements:
 - Minimum Conductor Size: 2 x 14AWG stranded Copper
 - Maximum Operating Voltage: 300V RMS
 - Nominal Conductor DC Resistance: 2.86Ω/1000ft
 - Nominal Capacitance: 36 pF/ft.
 - Nominal Inductance: 0.19 μH/ft.

- Insertion Loss shall be less than: 0.2 dB
- Plenum rated
- Insulation Material: Low Smoke Polyvinyl Chloride
- Outer Jacket: Low Smoke Polyvinyl Chloride
- Operating Temperature: 0 to +75° C

C. Speaker cable shall be suitable for indoor use.

D. Speaker cable shall comply with UL Flame Test NFPA 262

E. Speaker cable shall comply with NEC Specification CMP and NEC Article 800.

2.19 AV Equipment Rack

A. The contractor shall furnish 2 AV equipment racks in rooms G134 and G318.

B. The AV equipment rack shall be 20 rack units high and have 19” rack mounting rails.

C. The overall dimensions of the AV equipment rack shall not exceed 24” W x 40” H x 24” D.

D. The AV equipment rack shall have industrial casters for easy movement.

E. The AV equipment rack shall include horizontal rack mounted wire management.

Construction Methods:

3.01 Installation of 60” Video Display Cubes

A. The Contractor shall furnish, install, and configure thirty three video display cubes in an eleven wide by three high VDA with support frame located in the highway operations center room G300 as shown on the contract plans. Refer to contract phasing plans for installation timeline.

B. The Contractor shall furnish, install, and configure twelve video display cubes in a four wide by three high VDA with support frame located in the storm center room G301 as shown on the contract plans. Refer to contract phasing plans for installation timeline.

C. The Contractor shall un-pack video display cubes and monitors in the presence of the Engineer. The Engineer shall reject damaged video display cubes.

D. The Contractor shall install the video wall support frames on top the concrete floor and level to suit the video wall manufacturer’s requirements. The Contractor shall

- install the support frames so the bottom of the display cube sill height is forty-eight inches above the existing raised floor height. The Contractor shall anchor the support frame into the concrete floor and provide safety straps at the top of the VDA's to keep the wall from falling over in the event of an earth quake.
- E. The Contractor along with the Mitsubishi manufacturer representative shall install the video wall cubes on the new support frames. The Contractor and manufacturer representative shall install and adjust the screens so that picture alignment is within 1 to 5 mm across adjacent video wall screens. Screen gaps shall be within manufacturer recommended tolerances.
 - F. The Contractor shall install new electrical power strips and cabling with 120 volt 20 amp receptacles from existing electrical junction boxes under the raised floor to each video wall support frame. The Contractor will connect to existing UPS powered electrical circuits designated for powering the video display cubes.
 - G. The video display cubes shall be installed so that cool air enters from the bottom of the support frame and exits directly into the ceiling return air plenum. The Contractor shall ensure proper passive ventilation is provided for all video display cubes according to manufacturer recommendations.
 - H. The Contractor shall furnish, install, and configure the compatible ThinkLogical fiber optic receiver card into each Mitsubishi video display cube and ensure the compatible firmware version is running on each video display cube.
 - I. The Contractor shall furnish, install, and configure the compatible ThinkLogical fiber optic transmitter in an equipment rack as determined by the Engineer located in the VDTR Room G303. The Contractor shall install the transmitter within the manufacturers rack mounted chassis.
 - J. The Contractor shall furnish and install duplex Fiber optic cables from each video display cube to the compatible rack mounted ThinkLogical fiber optic transmitter card located in the highway operations VDTR Room G303. The Contractor shall install fiber optic cables in the cable trough under the raised floor, through conduit sealing sleeves, and into the fiber optic cable management system. The Contractor shall ensure fiber optic cables are bundled in inner-duct and be kept separate from copper cabling when running in the under floor cable trough. The fiber optic cables shall be kept continuous with no splices.
 - K. The VDA shall not daisy chain video communications from one display cube to another. There shall be a direct video connection from the video display processor to each display cube.
 - L. The Contractor shall connect control cables between each video display cube for automatic brightness and color balancing. Each VDA assembly shall be connected independently of each other.

- M. The Contractor shall connect category 6A cables to each video display cube to terminate into an unmanaged Ethernet switch located at the bottom of each support frame.
- N. All cabling shall be plenum rated, continuous with no splices, labeled on both ends with unique identifiers, and neatly tied and anchored for the entire run of the cable. No cables will be allowed to run along exterior surfaces unless approved by the engineer.
- O. The Contractor along with the manufacturer representative (Mitsubishi) shall perform color balancing, convergence, and image alignment on all video display cubes for each VDA after the VDP is installed and functioning.
- P. Contractor shall attach removable acoustic filler panels between the walls and the video wall support frame and display cubes, as shown on the construction plans. The filler panels will cover all open spaces around the support frame and display cubes. The filler panels shall be installed so that easily removable acoustic panels will be flush to the wall face. Acoustic panels will be cut so that the front access display cubes can still be serviced without removing the acoustic panels. Filler panels at the top of each VDA shall be constructed so heat exhausting from the video display cubes is not blocked or obstructed from returning to the ceiling return air plenum.

3.02 Installation of 55" flat panel displays

- A. The Contractor shall furnish, install, and configure two 55" flat panel displays in the Highway Operations Center Entrance. The displays shall be mounted on the wall near the HOC entrance, at the location shown in the contract drawings in a one wide by two high VDA. The Contractor shall furnish and install one compatible front access wall mount bracket for each display. Refer to contract phasing plans for installation timeline.
- B. The Contractor shall furnish, install, and configure nine 55" flat panel displays in the TIM Room G114 North Side in a three wide by three high VDA. The displays shall be mounted on the wall at the location shown in the contract drawings. The Contractor shall furnish and install nine compatible front access wall mount brackets for each display. Refer to contract phasing plans for installation timeline.
- C. The Contractor shall furnish, install, and configure nine 55" flat panel displays in the TIM Room G114 South Side in a three wide by three high VDA. The displays shall be mounted on the wall at the location shown in the contract drawings. The Contractor shall furnish and install nine compatible front access wall mount bracket for each display. Refer to contract phasing plans for installation timeline.
- D. The Contractor shall furnish, install, and configure one 55" flat panel display in the Engineering collaboration station room G308. The display shall be mounted on the collaboration station at the location shown in the contract drawings. The Contractor will coordinate with the manufacturer of the collaboration station for installation.

Refer to contract phasing plans for installation timeline.

- E. The Contractor shall un-pack 55” flat panel displays in the presence of the Engineer. The Engineer shall reject damaged flat panel displays.
- F. The Contractor shall install the flat panel display front access wall mounts at the proper sill heights as shown on the contract plans. The Contractor shall ensure the wall at each mounting location can properly support the weight of the 55” flat panel display with front access mounting bracket.
- G. The Contractor along with the manufacturer (Mitsubishi) representative shall install the 55” flat panel displays in a landscape orientation on the new front access wall mounts. The Contractor and manufacturer representative shall install and adjust the screens so that picture alignment and screen gaps between adjacent flat panel displays are within manufacturer recommended tolerances.
- H. The Contractor shall connect each flat panel display to a UPS powered 120 volt outlet located behind the displays. When connecting multiple displays and DVI/HDMI fiber optic receivers to electrical outlets, the Contractor shall provide power strips as necessary.
- I. The Contractor shall ensure proper passive ventilation is provided for all 55” flat panel displays according to manufacturer recommendations. Ventilation for the displays shall be designed for a 24/7 continuous operation.
- J. The Contractor shall furnish, install, and configure twenty DVI/HDMI Fiber Optic receivers behind all 55” flat panel displays except the display located in the engineering collaboration station room G308.
- K. The Contractor shall furnish, install, and configure the compatible twenty DVI/HDMI fiber optic transmitter in an equipment rack as determined by the Engineer located in the VDTR room G303. The Contractor shall install the transmitter within the manufacturers rack mounted chassis.
- L. For displays located in the highway operations hallway the Contractor shall furnish and install duplex fiber optic cables and modular wall jacks from each DVI/HDMI receiver to the compatible DVI/HDMI transmitter card located in the highway operations VDTR room G303. The Contractor shall install fiber optic cables in the cable trough under the raised floor, through conduit sealing sleeves, and into the fiber optic cable management system. The Contractor shall ensure fiber optic cables are bundled in inner-duct and be kept separate from copper cabling when running in the under floor cable trough. The fiber optic cables shall be kept continuous with no splices.
- M. For displays located in the TIM room G114 the Contractor shall furnish and install duplex fiber optic cables from the rack mounted DVI/HDMI fiber optic transmitters to the existing multimode fiber optic patch panel located in the VDTR room. The

- Contractor shall furnish and install duplex fiber optic cables from the Storage room G134 fiber optic patch panel to the TIM room G114 north fiber optic wall jack and TIM room G114 south fiber optic wall jack. The Contractor shall provide patch cables from the DVI/HDMI fiber optic receiver to the G114 north and south wall jacks. The contractor shall furnish and install both fiber optic north and south modular wall jacks and plates.
- N. The LCD flat panel display shall not daisy chain video communications from one monitor to another. There shall be a direct video connection from the Video Display Processor to each LCD flat panel display.
 - O. The Contractor shall furnish and install control cables between each 55" flat panel display for automatic brightness and color balancing when the display is part of a VDA. Each VDA shall be connected independently of each other.
 - P. The Contractor shall connect category 6A patch cables to existing category 6A wall jacks for two 55" flat panel displays located at the highway operations center entrance.
 - Q. All cabling shall be plenum rated, continuous with no splices, labeled on both ends with unique identifiers, and neatly tied and anchored for the entire run of the cable. No cables will be allowed to run along exterior wall surfaces unless approved by the engineer.
 - R. The Contractor along with the Mitsubishi manufacturer representative shall perform color balancing, convergence, and image alignment on all 55" flat panel displays for each VDA after the VDP is installed and functioning.
 - S. Contractor shall attach removable acoustic filler panels between the walls and the 55" flat panel displays located in TIM room G114, as shown on the construction plans. The filler panels will cover all open spaces around the 55" flat panel displays. The filler panels shall be installed so that easily removable acoustic panels will be flush to the wall face. Acoustic panels will be cut so that the front access 55" flat panel displays can still be serviced without removing the acoustic panels. Filler panels at the top of each VDA shall be constructed so heat exhausting from the 55" flat panel displays is not blocked or obstructed from returning to the ceiling return air plenum.

3.03 Installation of 84" Flat Panel Display

- A. The Contractor shall furnish, install, and configure one 84" flat panel display in Highway Operations Center Conference Room G302. The display shall be mounted on the wall near the conference room entrance, at the location shown in the contract drawings. The Contractor shall furnish and install one compatible wall mount bracket for the display. Refer to contract phasing plans for installation timeline.

- B. The Contractor shall un-pack 1 new one 84” flat panel display in the presence of the Engineer. Any damage shall be noted. The Engineer shall reserves the right to reject damaged flat panel displays due to manufacturing, shipping, handling or installation. The Contractor shall be responsible for returning and replacing any material damaged as noted herein
- C. The Contractor shall install the flat panel display wall mounts at the proper sill height of 48 inches as shown on the contract plans. The Contractor shall ensure the wall at the mounting location can properly support the weight of the 84” flat panel display with mounting bracket.
- D. The Contractor shall install the 84” flat panel display in a landscape orientation on the new wall mount.
- E. The Contractor shall connect the flat panel display to a UPS powered 120 volt outlet located behind the display. When connecting the display and DVI/HDMI fiber optic receiver to electrical outlets, the Contractor shall provide a power strip if necessary.
- F. The Contractor shall furnish, install, and configure one DVI/HDMI Fiber Optic receiver behind the 84” flat panel display for connection to the VDP.
- G. The Contractor shall furnish, install, and configure the compatible DVI/HDMI fiber optic transmitter in an equipment rack as determined by the Engineer located in the VDTR room G303. The Contractor shall install the transmitter within the manufacturers rack mounted chassis.
- T. The Contractor shall furnish and install a duplex Fiber optic cable and modular wall jack from the DVI/HDMI receiver to the compatible DVI/HDMI transmitter card located in the highway operations VDTR room G303. The Contractor shall install fiber optic cable in the cable trough under the raised floor, through conduit sealing sleeves, and into the fiber optic cable management system. The Contractor shall ensure fiber optic cables are bundled in inner-duct and be kept separate from copper cabling when running in the under floor cable trough. The fiber optic cables shall be kept continuous with no splices.
- H. The Contractor shall furnish and install category 6A patch cable to category 6A wall jack for the 84” flat panel display.
- I. The Contractor shall furnish and install category 6A shielded cable and modular jack from the 84” flat panel display to the output of the Crestron room controller located in room G318. The installed cable must support HDBase-T signaling for uncompressed video up to 4K/60p.
- J. All cabling shall be plenum rated, continuous with no splices, labeled on both ends with unique identifiers, and neatly tied and anchored for the entire run of the cable.

No cables will be allowed to run along exterior wall surfaces unless approved by the engineer.

3.04 Installation of Video Wall Processor

- A. The Contractor shall furnish, install, and configure two VDP's in the highway operations VDTR room G303. The Contractor shall rackmount the VDP's in equipment racks as shown on the contract plans or as directed by the Engineer. VDP one (4000 series processor) will output video sources to the VDA at highway operations center room G300 and storm center room G301. VDP two (CRS4K series processor) will output video sources to the VDA at highway operations center entrance and the 84" display located in highway operations center conference room G302. Refer to contract phasing plans for installation timeline.
- B. The Contractor shall furnish, install, and configure one VDP in the highway operations VDTR room G303. The Contractor shall rackmount the VDP in equipment racks as shown on the contract plans or as directed by the Engineer. The VDP (4500 series processor) will output video sources to the VDA's TIM room G114 north side and TIM room G114 South Side. Refer to contract phasing plans for installation timeline.
- C. The Contractor shall connect each rack mounted VDP and DVI/HDMI fiber optic extender to an UPS powered 120/208 volt PDU's located at the rear of each equipment rack. When connecting supply power to equipment with redundant power supplies the Contractor shall connect equipment to PDU's on separate power circuits.
- D. The Contractor shall furnish and install DVI cables from the VDP DVI-D outputs to each rack mounted DVI/HDMI fiber optic transmitters and ThinkLogical fiber optic transmitters as shown in the contract plans audiovisual block diagram or as directed by the Engineer.
- E. The 4000 series VDP shall be configured to output 1920x1080 resolution to each display cube in both the highway operations center G300 11x3 VDA and storm room G301 4x3 VDA for a total aggregate resolution of 28800x3240.
- F. The 4500 series VDP shall be configured to output 1920x1080 resolution to each flat panel display in the TIM room G114 for both north and south 3x3 VDA's. The total aggregate resolution of both north and south 3x3 VDA's shall be 11520x3240.
- G. The CRS-4k VDP for the two 55" flat panel displays at the highway operations center entrance hall and the 84" flat panel display in highway operations conference room G302 shall be configured to output 1920x1080 resolution to each of the 3 displays.
- H. The contractor shall connect the control source RS-232 input from the CRS-4k to the room controller RS-232 output located in room G302. The contractor shall configure and integrate the VDP control port to allow for layout and source selections from the Crestron room controller located in the highway operations conference room G302.

- I. The Contractor shall furnish and install an HDMI/DVI cable from the DVI/HDMI fiber optic receiver to the TIM room VDP (4500 series processor) DVI-I input. The Contractor shall configure the input source for full HD (1920x1080) resolution. The Contractor shall connect the control source output (RS-232) from the DVI/HDMI fiber optic receiver to the TIM room VDP RS-232 input. The Contractor shall configure and integrate the VDP control port input to allow for layout and source selections from the Crestron room controller located in TIM room G114.
- J. The Contractor shall furnish and install DVI cables from Department-supplied ITS and enterprise PC outputs to the VDP DVI-I inputs. The Contractor shall configure all the input sources for full HD (1920x1080) resolution. The Contractor shall furnish, install, and configure EDID minders to all VDP PC source inputs to prevent PC computers from deactivating inactive DVI ports or putting DVI outputs into sleep mode.
- K. The Contractor shall furnish and install CAT6A patch cables from the VDP's IP decoder inputs and LAN ports to the patch panel located at the bottom of each respective equipment rack. The Contractor will then install CAT6A patch cables from the VDTR ITS network switch to the corresponding patch panel location. The patch cables shall make a complete network connection from all the VDP's decoder inputs and LAN ports to the VDTR ITS network switch.
- L. The Contractor shall furnish, install, and configure one rack mounted OTA tuner and connect to the DVI-I inputs on the VDP as shown in the contract plans audiovisual block diagram or as directed by the Engineer. The Contractor shall connect the tuner to a OTA antenna cable that is located in the VDTR room G303. The Contractor shall then connect the stereo audio output to the department supplied audio distribution amplifier. The Contractor shall furnish any needed cable adapters to make a video connection to the VDP.
- M. The Contractor shall install and configure (3) Department-supplied HD CATV tuners and connect the HD outputs to the DVI-I inputs on the VDP as shown in the contract plans audiovisual block diagram or as directed by the Engineer. The Contractor shall rack mount, power, and connect the tuners to CATV supplied RG-6 input cables located in the VDTR room G303. The Contractor shall connect stereo audio outputs of the HD CATV tuners to the Department-supplied audio distribution amplifier.
- N. The Contractor shall furnish, install, and configure three RF receivers and universal remote controls in the highway operations center room G300, Area G301 Storm Center, and Area G302 HOC Conference Room. The Contractor shall furnish, install, and configure six IR emitters to control three cable tuners and one OTA tuner located in the VDTR room G303. The system shall have the ability to control any cable tuner even of the same model and manufacturer from any of the three locations. The Contractor shall program each cable tuner into all three universal remote controls for individual control of each cable tuner. The Contractor shall customize the display

name on the universal remote for each cable tuner as directed by the Engineer. The Contractor shall furnish and install all necessary cables between the three universal remote control receivers to the universal remote controller emitter located in the VDTR room G303.

- O. All cabling shall be continuous with no splices, labeled on both ends with unique identifiers, and neatly tied and anchored to existing equipment rack cable management. All cables shall be plenum rated if installed above the ceiling or below the raised floor.
- P. The Contractor shall furnish, install, and configure digital KVM extenders for Department-supplied enterprise PC's as directed by the Engineer. The Contractor shall configure each KVM extender for full HD output (1920X1080). The Contractor shall configure each extender with a Department-supplied network address. The Contractor shall furnish and install the cables necessary to connect each PC to the KVM extender and to the ITS VDTR network switch for full KVM control using the VDP client software.
- Q. The Contractor shall furnish, install, and configure H.264 video encoders for Department-supplied ITS PC's as directed by the Engineer. The Contractor shall configure each H.264 video encoder for full HD output (1920X1080) at a minimum 30 frames per second. The Contractor shall configure each extender with a Department-supplied unique multicast network stream address and unique unicast management address. The Contractor shall furnish and install the cables necessary to connect each PC to the KVM extender and to the ITS VDTR network switch for full KVM control using the VDP client software.
- R. The Contractor and Jupiter factory representative shall configure all the IP decoder input cards on the VDP's to decode multicast network streams from Contractor furnished H.264 HD video encoders and Department furnished H.264 SD video encoders.
- S. Each of the three furnished VDP processors shall include a canvas client for access to the Canvas Server. The Contractor and Jupiter factory representative will configure each VDP Canvas client to connect to the Canvas Server.
- T. The Contractor and Jupiter factory representative shall furnish, install, and configure twelve VDP canvas named client software packages on Department-supplied computers in rooms G305, G306, G307. The Contractor and Jupiter factory representative shall furnish, install, and configure twelve VDP Canvas floating license client software packages on Department-supplied computers in rooms G300, G301, G302, and G114. The Contractor and Jupiter factory representative shall configure the Canvas clients for connectivity to the VDP with the ability to take full KVM control of any Contractor installed KVM extender, H.264 PC video encoder, or VDP.

- U. The Contractor and Jupiter factory representative shall furnish, install, and configure two VDP canvas server software packages on Department-supplied virtual servers. The Contractor and Jupiter factory representative shall configure the server software to allow connections to all the clients along with system wide user access groups. The Contractor and Jupiter factory representative shall configure a minimum of three user access groups and access policies.
- V. The Contractor and Jupiter factory representative shall configure the output of each VDP to the correct VDA matrix for each processor or as directed by the Engineer. The Contractor and Jupiter factory representative shall setup a minimum of five layouts with hot keys assigned for each VDP.
- W. The contractor and Jupiter factory representative shall configure all direct source inputs and decoded source inputs from each CATV tuner, OTA tuner, H.264 video encoders, digital KVM extenders, and owner contractor multicast streams.
- X. The Contractor and Jupiter factory representative shall configure all VDP's, Canvas Clients, and Canvas Servers to all work as a single system.

3.05 Audio Visual Equipment Installation

3.05.1 G302 HOC Conference Room

- A. The conference room shall have a single independent room controller installed for local audio and video switching. The Contractor shall furnish, install, and configure the following AV equipment in room G302 and G318:
 - One Crestron AV room controller
 - Two Crestron touch panel screens
 - One Crestron line amplifier
 - Four Crestron 6" ceiling speakers
 - One wireless presentation
 - One five port POE Ethernet switch
 - One AV Equipment Rack
- B. The Contractor shall refer to the contract phasing plans for installation timeline for all the AV equipment installed for room G302 and G318.
- C. The Contractor shall install an equipment rack with rack mounted power strip in the communication closet G318 to house the AV room controller, Crestron line amplifier, wireless presentation system, and five port POE Ethernet switch.
- D. The Contractor shall connect all AV equipment to UPS powered 120 volt outlets.

- E. The Contractor shall connect the AV room controller network output to the five port POE Ethernet switch. The Contractor shall connect the AV room controller low level speaker outputs to the Compatible Crestron amplifier.
- F. The Contractor shall install two 7" touch panel displays for connection and management of the AV equipment. One touch panel will be mounted on the wall as shown on the contract plans. The second touch panel display shall be mounted in the conference room G302 table or as directed by the Engineer. Touch panels will communicate to the room controller and be powered by the rack mounted five port POE Ethernet switch.
- G. The Contractor shall mount the wireless presentation system on the top of the equipment rack so wireless antennas are not obstructed. The Contractor shall connect the HDMI output of the wireless presentation to an HDMI input on the Crestron AV room controller. The Contractor shall configure the video output of the wireless presentation to support audio and video at full HD 1920x1080. If required the Contractor may need to relocate the wireless presentation or receiving antennas to allow full audio and video reception from any location within conference room G302.
- H. The Contractor shall connect a Department-supplied enterprise PC located in room G318 to an HDMI input on the Crestron AV room controller. The Crestron room controller HDMI input shall be configured to support audio and video at full HD 1920x1080 up to 4K/60p from the PC source computer.
- I. The Contractor shall connect the Crestron AV room controller HDBase-T output to an 84" flat panel display. The HDBase-T output from the Crestron room controller shall be configured to support full HD 1920x1080 up to 4K/60p. The HDBase-T output shall include the control signal for the 84" flat panel display.
- J. The Contractor shall integrate the Crestron AV room controller to the CRS-4k VDP. The Crestron controller will call programmed layouts that will display sources from the VDP on the 84" flat panel display.
- K. The Contractor shall install four ceiling speakers with the proper installation kit for drop ceilings within a plenum air return. The speaker system shall be setup to run from either 70V or 100V amplifier. The Contractor shall set the transformer taps on all speakers to match. The Contractor shall connect the speaker output from the amplifier to each speaker in series.
- L. The Contractor shall install all necessary HDMI, DVI, speaker cable, CAT 6A UTP, and CAT 6 STP (HDBase-T) cables within room G302 for a complete working system including the AV room controller, touch screen display, POE Ethernet switch, wireless presentation, enterprise PC, 84" flat panel display, amplifier, and speakers. Data cables that pass through floor box locations shall have 8 foot coils to accommodate potential future room configuration changes.

- M. The AV room controller shall be integrated into the room lighting controller for selecting a minimum of three programmed lighting levels. The Contractor shall coordinate with the lighting controller Contractor.
- N. The Contractor shall configure the room controller to have the following minimum device controls from the touch screen:
- Room volume control Up/Down
 - Room Preset lighting level selections for each lighting circuit
 - 84” flat panel display Power On/Off
 - 84” flat panel display Input selection
 - Presentation lighting selection (lighting circuit closest to video display turned off and remaining lights dimmed to preset level)
- O. The Contractor shall configure the room controller to have the following minimum macro selections from the touch screen:
- “CCTV” macro will select the proper input that is directly connected to the 84” flat panel display from the VDP CRS-4k. The macro shall also select the appropriate layout on the integrated VDP.
 - “CATV” macro will select the proper input that is directly connected to the 84” flat panel display from the VDP CRS-4k. The macro will select the appropriate audio input on the room controller for outputting audio through the ceiling speakers. The macro shall also select the appropriate layout on the integrated VDP.
 - “ATMS” macro will select the proper input that is directly connected to the 84” flat panel display from the VDP CRS-4k. The macro will select the appropriate audio input on the room controller for outputting audio through the ceiling speakers. The macro shall also select the appropriate layout on the integrated VDP.
 - “Laptop” macro will select the proper input on the 84” flat panel display and AV room controller to display the video and audio output from the wireless presentation.
 - “PC” macro will select the proper input on the 84” flat panel display and AV room controller to output video and audio from the department supplied PC source computer.

3.05.2 G117 and G118 Conference Rooms

- A. Each conference room shall have a single independent room controller installed for local audio and video switching. The Contractor shall furnish, install, and configure the following AV equipment in each conference room:
- One Crestron AV room controller
 - One Laser Projector
 - Two Crestron touch panel screens

- One Crestron line amplifier
 - Four Crestron 6" ceiling speakers
 - One wireless presentation
 - One five port POE Ethernet switch
 - One podium
- B. The Contractor shall refer to the contract phasing plans for installation timeline for all the AV equipment installed for conference rooms G117 and G118.
- C. The laser projector installed in both conference rooms G117 and G118 shall be mounted to the ceiling using the proper drop ceiling mounting bracket.
- D. The laser projector screen shall project an image on each conference room wall that is a minimum 120 inches diagonal using a 16:10 aspect ratio based upon the proposed location of the projector as detailed on the contract plans. The height from the top of the floor to the bottom of the projected wall image shall be 48 inches.
- E. The Contractor shall install a podium within each room in the location shown on the contract plans. The Contractor shall install the AV room controller, Crestron line amplifier, wireless presentation system, and five port POE Ethernet switch within the podium.
- F. The Contractor shall connect all AV equipment to UPS powered 120 volt outlets from the floor box located below the podium.
- G. The Contractor shall connect each AV room controller network output to the five port POE Ethernet switch. The Contractor shall connect each AV room controller low level speaker outputs to the Compatible Crestron amplifier.
- H. The Contractor shall install two 7" touch panel displays for connection and management of the AV equipment within each conference room. A touch panel will be mounted on the wall as shown on the contract plans within each conference room. The second touch panel display in each conference room shall be mounted to the podium. Touch panels within each conference room will communicate to the room controller and be powered by the rack mounted five port POE Ethernet switch.
- I. The Contractor shall mount each wireless presentation system within the podium. The Contractor shall connect the HDMI output of the wireless presentation to an HDMI input on the Crestron AV room controller. The Contractor shall configure the video output of the wireless presentation to support audio and video at 1920x1200 resolution. If required the Contractor may need to relocate the wireless presentation or receiving antennas to allow full audio and video reception from any location within the conference room.

- J. The Contractor shall connect a Department-supplied enterprise PC located in each conference room podium to an HDMI input on the Crestron AV room controller. The Crestron room controller HDMI input shall be configured to support audio and video at 1920x1200 up to 4K/60p from the PC source computer.
- K. The Contractor shall connect each Crestron AV room controller HDBase-T output to an laser projector. The HDBase-T output from the Crestron room controller shall be configured to support full 1920x1200 up to 4K/60p. The HDBase-T output shall include the control signal for the laser projector.
- L. The Contractor shall install four ceiling speakers with the proper installation kit for drop ceilings within a plenum air return. The speaker system shall be setup to run from either 70V or 100V amplifier. The Contractor shall set the transformer taps on all speakers to match. The Contractor shall connect the speaker output from the amplifier to each speaker in series.
- M. The Contractor shall install all necessary HDMI, DVI, speaker cable, CAT 6A UTP, and CAT 6 STP (HDBase-T) cables within room G302 for a complete working system including the AV room controller, touch screen display, POE Ethernet switch, wireless presentation, enterprise PC, laser projector, amplifier, and speakers. Data cables that pass through floor box locations shall have 8 foot coils to accommodate potential future room configuration changes.
- P. The AV room controller shall be integrated into each room lighting controller for selecting a minimum of three programmed lighting levels. The Contractor shall coordinate with the lighting controller Contractor.
- Q. The Contractor shall configure each room controller to have the following minimum device controls from the touch screen:
- Volume control Up/Down
 - Preset lighting level selections for each lighting circuit
 - Laser Projector Power On/Off
 - Presentation lighting selection (lighting circuit closest to video display turned off and remaining lights dimmed to preset level)
- R. The Contractor shall configure each room controller to have the following minimum macro selections from the touch screen:
- “Laptop” macro will select the proper input on the laser projector and AV room controller to display the video and audio output from the wireless presentation.
 - “PC” macro will select the proper input on the laser projector and AV room controller to output video and audio from the department supplied PC source computer.

3.05.3 G114 TIM Conference Room

- A. The conference room shall have a single independent room controller installed for local audio and video switching. The video and control output of the room controller shall be connected to the input of the TIM room VDP. The Contractor shall furnish, install, and configure the following AV equipment in room G114 and G134:
- One Crestron AV room controller
 - Three Crestron touch panel screens
 - Two Crestron DM transmitters
 - One Crestron line amplifier
 - Eight Crestron 6" ceiling speakers
 - One wireless presentation
 - One wireless microphone system
 - One five port POE Ethernet switch
 - One AV Equipment Rack
 - One Podium
 - Two DVI/HDMI fiber optic extenders
- B. The Contractor shall refer to the contract phasing plans for installation timeline for all the AV equipment installed for room G114 and G134.
- C. The Contractor shall install an equipment rack with rack mounted power strip in the communication closet G134 to house the AV room controller, wireless microphone system, and five port POE Ethernet switch.
- D. The Contractor shall connect all AV equipment in the equipment rack and podium to UPS powered 120 volt outlets.
- E. The Contractor shall install a podium within the room at the front center location as shown on the contract plans. The Contractor shall install the wireless presentation system, and Crestron DM transmitters within the podium. The Contractor shall furnish and install a balanced XLR connection for a wired microphone at the podium and connect the wiring to a balanced line input on the Crestron AV room controller.
- F. The DM transmitters shall send The HDBase-T/DM video and audio output to the Crestron room controller DM inputs and shall be configured to support full HD 1920x1080 up to 4K/60p.
- G. The Contractor shall connect the AV room controller network output to the five port POE Ethernet switch. The Contractor shall connect the AV room controller low level speaker outputs to the Compatible Crestron amplifier to power all eight 6" ceiling speakers.
- H. The Contractor shall install three 7" touch panel displays for connection and management of the AV equipment. Two touch panels will be mounted on the walls as shown on the contract plans. The third touch panel display shall be mounted on the

podium. Touch panels will communicate to the room controller and be powered by the rack mounted five port POE Ethernet switch.

- I. The Contractor shall mount the wireless microphone system on the top of the equipment rack so wireless antennas are not obstructed. The Contractor shall connect the balanced line output of the wireless microphone system to a balanced line input on the Crestron AV room controller. The Contractor shall configure and connect the two included wireless microphones to the receiver. If required the Contractor may need to relocate the receiving antennas to allow full audio reception from any location within the conference room G114.
- J. The Contractor shall mount the wireless presentation system within the podium. The Contractor shall connect the HDMI output of the wireless presentation to a Crestron DM transmitter for input into the Crestron AV room controller. The Contractor shall configure the video output of the wireless presentation to support a video resolution at 1920x1080. If required the Contractor may need to relocate the wireless presentation or receiving antennas to allow full audio and video reception from any location within the conference room G114.
- K. The Contractor shall connect a Department-supplied enterprise PC located in the podium to the HDMI input on the Crestron DM transmitter. The Contractor shall configure the video output of the enterprise PC to support a video resolution at 1920x1080 60Hz.
- L. The Contractor shall connect each Crestron AV room controller HDMI and control output to a rack mounted HDMI/DVI fiber optic transmitter. The HDMI output from the Crestron room controller shall be configured to support 1920x1080 60Hz. The Contractor shall integrate the Crestron AV room controller to the designated TIM room VDP. The Crestron controller will call a programmed layout that shows a mirror image of the AV room controller output on both TIM room North and South VDA assemblies.
- M. The Contractor shall furnish, install, and configure the control cables to both TIM room North and South VDA assemblies for controlling all 55" flat panel displays. Control of the displays shall include but not limited to Input selection, Power ON, and Power Off.
- N. The Contractor shall install eight ceiling speakers with the proper installation kit for drop ceilings within a plenum air return. The speaker system shall be setup to run from either 70V or 100V amplifier. The Contractor shall set the transformer taps on all speakers to match. The Contractor shall connect the speaker output from the amplifier to each speaker in series.
- O. The Contractor shall install all necessary HDMI, DVI, OM4 multimode fiber, speaker cable, CAT 6A UTP, and CAT 6 STP (HDBase-T) cables within room G114 for a

complete working system including the AV room controller, touch screen display, POE Ethernet switch, wireless presentation, wireless microphone system, enterprise PC, wiring for hard wired microphone, amplifier, and speakers. Data cables that pass through floor box locations shall have 8 foot coils to accommodate potential future room configuration changes.

- S. The AV room controller shall be integrated into each room lighting controller for selecting a minimum of three programmed lighting levels. The Contractor shall coordinate with the lighting controller Contractor.
- T. The Contractor shall configure each room controller to have the following minimum device controls from the touch screen:
- Room G114 volume control
 - Room G114 preset lighting level selections for each lighting circuit.
 - VDA 3x3 matrix North power On/Off
 - VDA 3x3 matrix South power On/Off
 - Presentation lighting selection (lighting circuit closest to VDA's turned off and remaining lights dimmed to preset level)
- U. The Contractor shall configure each room controller to have the following minimum macro selections from the touch screen:
- "Laptop" macro will select the proper input on both north and south VDA's and AV room controller to output video and audio from the wireless presentation. The macro shall also select the appropriate layout on the integrated VDP.
 - "PC" macro will select the proper input on both north and south VDA's and AV room controller to output video and audio from the department supplied enterprise PC source computer. The macro shall also select the appropriate layout on the integrated VDP.
- 3.06 Configuration: For each applicable phase of the project, the Contractor shall configure the video and graphics wall equipment according to the requirements contained within this specification and to manufacturer's instructions.
- 3.07 Field Quality Control (Preliminary Testing): The Contractor shall demonstrate all requirements of the equipment and shall demonstrate complete operability with all connected equipment. The Contractor shall certify that the installation is complete and operates according to specified requirements. The Contractor shall provide operation and maintenance manuals so that they can be reviewed by the Department. Once said documents are determined to be acceptable to the Department, the Contractor may schedule the start of the 30 Day System Operational Test described.
- 3.08 Testing: Upon successful completion of the configuration and preliminary testing of the video and graphics wall equipment to the satisfaction of the Engineer, a 30 Day System Operational Test shall commence for each applicable phase of the Project.

The complete system shall remain fully operational at all times for the test period. If a malfunction occurs within the stated time frame, the Contractor shall make necessary repairs to the video and graphics wall equipment and re-establish proper operation at no additional cost to the Engineer. Upon the approval of the Engineer, the 30 Day System Operational Test will start over. All components that comprise the video and graphics wall equipment shall operate a full 30 consecutive days without a malfunction before the system will be accepted by the Engineer.

The Contractor shall notify the highway operations staff 2 weeks before the anticipated start of the test. The Contractor shall be responsible for coordination of the 30 Day System Operational Test of the video and graphics wall equipment. The Contractor shall make available a telephone number to the highway operations staff for reporting malfunctions. The Contractor shall respond to malfunctions within 24 hours of being notified. All malfunctions will be brought to the attention of the Engineer.

The 30 Day System Operational Test shall not be permitted to end until all necessary spare parts have been received by the Engineer.

3.09 Training: Refer to Form 817 Article 1.20-1.08.14 subsection 3 for additional information.

After the system is installed and properly operating, a certified trainer from the approved manufacturer will conduct training. All training shall consist of instruction, demonstration, hands on experience, manuals and finish with a question and answer session. All training shall include printed hand-outs for each attendee covering the topics below in a quick reference format.

- a. Two (2) training sessions (1 on each shift for a minimum of 3 hours each) shall be for a maximum of (8) Operations Staff at each session for operating the new video and graphics wall systems. The training session syllabus shall cover a minimum of the following:
 - Identifying key components of the system
 - Understanding and demonstration of the VDP and associated control software
 - Hands on moving and re-sizing images on the VDAs.
 - Calling and selecting different images on the VDAs.
 - Navigating from one VDP to another.
 - Taking KVM control of PC sources.
- b. One (1) training session (6 hour minimum) shall be for a maximum of (8) Engineering Staff. The training session syllabus shall cover everything in training session 1 and additionally the following:
 - Identifying key components of the various Video Display Assemblies
 - Identifying parts and part numbers for various Video Display Assemblies
 - Changing dust filters (if applicable)

- Changing the LED light engine located in the display cube engine
- Swapping out the spare display cube engine
- Changing screen layouts in the VDP control software
- Creating display wall templates and presets in the VDP control software
- Adding video input sources to the VDP control software
- Updating VDP control software/firmware

Training material for Department staff shall include equipment documentation, as-built drawings, manufacturer service manuals, and manufacturer’s operational and equipment manuals.

3.10 Existing Video and Graphics Wall Removal: When directed by the Engineer, the Contractor shall remove the existing highway operations video and graphics wall that includes but shall not be limited to:

- 9 Mitsubishi 70 series lamp based DLP rear access cubes
- 20 Dotronix 27” CRT displays
- All associated video and graphics wall cabling for the displays.
- 40U equipment rack.
- All spare parts.

The Contractor shall refer to the Contract phasing plans for timing of the removal.

Method of Measurement: This item will be measured for payment at the contract lump sum price for “Video and Graphics Wall Equipment” of the type specified, installed, tested, and accepted in place.

Basis of Payment: This item will be paid for at the contract lump sum price for “Video and Graphics Wall Equipment” of the type specified, which price shall include all materials (including spare parts), submittals, warranties, shipping, labor, tools, adjustments to installed devices, disposal of removed equipment, training, travel, all equipment, and incidentals necessary to complete the work.

PAY ITEM
Video and Graphics Wall Equipment

PAY UNIT
LS

**INDEX OF CSI-FORMATTED SPECIFICATIONS
AND CORRESPONDING ITEM NUMBER
DEPARTMENT OF TRANSPORTATION HIGHWAY OPERATIONS CENTER
EXPANSION AND RENOVATION
NEWINGTON, CONNECTICUT
STATE PROJECT NO. 93-210**

<u>Item #</u>	<u>CSI Sect.</u>	<u>Description of Item</u>
DIVISION 3 - CONCRETE		
0177150A	033000	CAST-IN-PLACE CONCRETE
DIVISION 5 - METALS		
0177150A	051200	STRUCTURAL STEEL FRAMING
0177150A	055000	METAL FABRICATIONS
0177150A	055213	PIPE AND TUBE RAILINGS
DIVISION 6 – WOOD, PLASTICS, AND COMPOSITES		
0177150A	061000	ROUGH CARPENTRY
0177150A	068200	FIBERGLASS REINFORCED PLASTIC PRODUCTS
DIVISION 7 - THERMAL AND MOISTURE PROTECTION		
0177150A	072100	THERMAL INSULATION
0177150A	078100	APPLIED FIREPROOFING
0177150A	078413	PENETRATION FIRESTOPPING
0177150A	079200	JOINT SEALANTS
DIVISION 8 - OPENINGS		
0177150A	081416	FLUSH WOOD DOORS AND FRAMES
0177150A	083213	SLIDING ALUMINUM-FRAMED GLASS DOORS
0177150A	084113	ALUMINUM FRAMED STOREFRONTS AND ENTRANCES
0177150A	087100	DOOR HARDWARE
0177150A	088000	GLAZING
0177150A	089000	LOUVERS AND VENTS

DIVISION 9 - FINISHES

0177150A	092216	NON-STRUCTURAL METAL FRAMING
0177150A	092900	GYPSUM BOARD
0177150A	093000	TILING
0177150A	095113	ACOUSTICAL TILE CEILINGS
0177150A	096500	RESILIENT FLOORING
0177150A	096813	TILE CARPETING
0177150A	096900	ACCESS FLOORING
0177150A	099123	PAINTING

DIVISION 10 - SPECIALTIES

0177150A	101010	VISUAL DISPLAY SURFACES
0177150A	101400	SIGNAGE
0177150A	102600	WOOD WALL PANELING
0177150A	102800	TOILET AND BATH ACCESSORIES
0177150A	104400	FIRE-PROTECTION CABINETS AND EXTINGUISHER

DIVISION 11 - EQUIPMENT

0177150A	113100	APPLIANCES
----------	--------	------------

DIVISION 12 - FURNISHINGS

0177150A	122113	LOUVER BLINDS
0177150A	123213	MANUFACTURED WOOD-VENEER-FACED CASEWORK
0177150A	123216	PLASTIC LAMINATED CASEWORK
0177150A	123600	COUNTERTOPS
0177150A	124813	ENTRANCE FLOOR MATS AND FRAMES

DIVISION 21 – FIRE SUPPRESSION

0177150A	210517	SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING
0177150A	210518	ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING
0177150A	210548	VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT
0177150A	210553	IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT
0177150A	211200	FIRE-SUPPRESSION STANDPIPES
0177150A	211313	WET-PIPE SPRINKLER SYSTEMS
0177150A	211319	PREACTION SPRINKLER SYSTEMS
0177150A	212200	CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

DIVISION 22 – PLUMBING

0177150A	220516	EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING
0177150A	220517	SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING
0177150A	220518	ESCUTCHEONS FOR PLUMBING PIPING
0177150A	220523	GENERAL DUTY VALVES FOR PLUMBING PIPING
0177150A	220529	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT
0177150A	220548	VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT
0177150A	220553	IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT
0177150A	220719	PLUMBING PIPING INSULATION
0177150A	221116	DOMESTIC WATER PIPING
0177150A	221119	DOMESTIC WATER PIPING SPECIALTIES
0177150A	221316	SANITARY WASTE AND VENT PIPING
0177150A	221319	SANITARY WASTE PIPING SPECIALTIES
0177150A	221423	STORM DRAINAGE PIPING SPECIALITES
0177150A	224213	COMMERCIAL WATER CLOSETS
0177150A	224216	COMMERCIAL LAVATORIES AND SINKS
0177150A	224713	DRINKING FOUNTAINS

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING

0177150A	230517	SLEEVES AND SLEEVE SEALS FOR HVAC PIPING
0177150A	230518	ESCUTCHEONS FOR HVAC PIPING
0177150A	230519	METERS AND GAGES FOR HVAC PIPING
0177150A	230523	GENERAL-DUTY VALVES FOR HVAC PIPING
0177150A	230529	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT
0177150A	230548	VIBRATION AND SEISMIC CONTROLS FOR HVAC
0177150A	230553	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT
0177150A	230593	TESTING, ADJUSTING, AND BALANCING FOR HVAC
0177150A	230713	DUCT INSULATION
0177150A	230719	HVAC PIPING INSULATION
0177150A	230900	INSTRUMENTATION AND CONTROL FOR HVAC
0177150A	230994	SEQUENCE OF OPERATION
0177150A	232113	HYDRONIC PIPING
0177150A	232116	HYDRONIC PIPING SPECIALTIES
0177150A	232300	REFRIGERANT PIPING
0177150A	233113	METAL DUCTS
0177150A	233300	AIR DUCT ACCESSORIES

DIVISION 23 – HEATING, VENTILATING AND AIR CONDITIONING

0177150A	233423	HVAC POWER VENTILATORS
0177150A	233713	DIFFUSERS, REGISTERS, AND GRILLES
0177150A	237313	MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS
0177150A	238126	SPLIT-SYSTEM AIR CONDITIONERS
0177150A	238233	CONVECTORS

DIVISION 26 - ELECTRICAL

0177150A	260519	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
0177150A	260526	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
0177150A	260529	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
0177150A	260533	RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS
0177150A	260544	SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING
0177150A	260548	SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS
0177150A	260553	IDENTIFICATION FOR ELECTRICAL SYSTEMS
0177150A	260923	LIGHTING CONTROL DEVICES
0177150A	262415	STATIC UNINTERRUPTIBLE POWER SUPPLY AND WALL MAINTENANCE BYPASS SWITCH
0177150A	262416	PANELBOARDS
0177150A	262726	WIRING DEVICES
0177150A	262727	FLOOR BOX WIRING DEVICE
0177150A	262728	TRACK BUSWAY
0177150A	262813	FUSES
0177150A	262816	ENCLOSED SWITCHES AND CIRCUIT BREAKERS
0177150A	265119	LED INTERIOR LIGHTING
0177150A	265219	EMERGENCY AND EXIT LIGHTING

DIVISION 27 – COMMUNICATIONS

0177150A	270526	GROUNDING AND BONDING
0177150A	271313	COMMUNICATIONS COPPER BACKBONE CABLING
0177150A	271513	COMMUNICATIONS COPPER HORIZONTAL CABLING
0177150A	275119	SOUND MASKING SYSTEMS
0177150A	276270	CENTRAL RADIO SYSTEM

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

0177150A	282300	VIDEO SURVEILLANCE
0177150A	281300	ACCESS CONTROL
0177150A	283100	FIRE ALARM SYSTEM

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section specifies cast-in-place concrete (interior and exterior), including formwork, reinforcement, concrete materials, mixture design, placement procedures, finishes for the following:
- B. Related CSI Sections include the following:
 - 1. Division 05 Section 055000, "Metal Fabrications" for furnishing metal embedment.

1.2 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For proprietary materials and items, including reinforcement and forming accessories, admixtures, joint systems, curing compounds, water repellents, sealants, colored hardener and others if requested by the Designer.
- C. Shop Drawings: For reinforcement detailing fabricating, bending, and placing concrete reinforcement. Comply with ACI 315 Detailing Manual – SP-66(94) showing bar schedules, stirrup spacing, bent bar diagrams, splices and laps and arrangement of concrete reinforcement. Include special reinforcing required for openings through concrete structures. For slabs with mechanically-connected steel reinforcement, indicate anchors and inserts locations, proposed locations of all control, expansion and construction joints not otherwise shown on the plans.
- D. Quality Assurance Submittals:
 - 1. Laboratory test reports for concrete materials and mix design test.
 - 2. Material certificates in lieu of material laboratory test reports when permitted by Engineer. Material certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.
 - 3. Evidence that concrete materials have been tested and the test results are on file with the State of Connecticut Department of Transportation Laboratory.

4. Certified Materials Test Reports for each lot of reinforcement showing that it complies with ASTM A 615.

1.3 QUALITY ASSURANCE:

- A. Codes and Standards: Comply with provisions of the following codes, specifications and standards, except where more stringent requirements are shown or specified:
 1. State of Connecticut Department of Transportation "Form 816," "Standard Specification for Roads, Bridges and Incidental Construction"
 2. ACI 301, "Specifications for Structural Concrete for Buildings."
 3. ACI 318, "Building Code Requirements for Reinforced Concrete."
 4. CRSI, "Manual of Standard Practice."
 5. ACI 315, "Details and Detailing of Concrete Reinforcement"
 6. ACI 347, "Recommended Practice for Concrete Formwork"
 7. ACI 304R, "Recommended Practice for Measuring, Mixing, Transportation and Placing Concrete"
 8. ACI 302.1R, "Guide for Concrete Floor and Slab Construction"
 9. ACI 305R, "Hot Weather Concreting"
 10. ACI 306R, "Cold Weather Concreting"
 11. ACI 306.1, "Standard Specifications for Cold Weather Concreting"
 12. ACI 308, "Standard Practice for Curing Concrete"
 13. 309R "Standard Practice for Consolidating of Concrete"
 14. ACI 211.1, "Standard Practice for Selecting Proportions for Normal, Heavy Weight and Mass Concrete"
 15. ACI 303.1 "Standard Specifications for Cast-In-Place Architectural Concrete"
 16. ASTM C309 "Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete"
 17. ASTM C494 "Standard Specifications for Chemical Admixtures for Concrete"
- B. Testing Agency Qualifications: An independent agency, acceptable to the Engineer to perform material evaluation tests and to design concrete mixes, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
- C. Materials and installed work may require testing and retesting at any time during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at the Contractor's expense.
- D. Concrete Testing Service: Engage a qualified independent testing agency, acceptable to the Engineer, to perform material evaluation tests and to design concrete mixtures. The Engineer or his designated representative will perform material evaluation tests on the concrete mixes designed by the Contractor.
- E. Conduct a Pre-Installation Meeting at the Project Site in compliance with the requirements of Form 816 Article 1.20-1.05.24, subsection 2.

1. Conduct a meeting to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend the meeting.
- F. 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 and color hardener through one source from a single manufacturer in accordance with Form 816 Article 1.20-1.06.01.
- 1.4 DELIVERY, STORAGE, AND HANDLING:
- A. Refer to Form 816 Article 1.06.03 and Form 816 Article 1.20-1.06.03 for additional information.
 - B. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963.
 - C. Water-stops: Store water-stops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS:

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel type material that will provide continuous, true, and smooth, exposed concrete surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on the plans.
 1. Use overlaid plywood complying with DOC PS-1 "A-C or B-B High Density Overlaid Concrete Form," Class I or better.
 2. Use plywood complying with DOC PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

- D. 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. Comply with local regulations controlling use of volatile organic compounds (VOC's).
- E. Form Ties: Factory-fabricated, adjustable length, 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. Provide units that will leave no corrodible metal closer than 1-1/2 inches to the plane of the exposed concrete surface.
 - 2. Provide ties that, when removed, will leave holes not larger than 1 inch in diameter in the concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 STEEL REINFORCEMENT:

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A 775, with less than 2 percent damaged coating in each 12-inch bar length.
- C. Plain-Steel Wire: ASTM A 82, cold-drawn steel.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.
- E. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884, Class A coated, Type 1, deformed steel.

2.3 REINFORCEMENT ACCESSORIES:

- A. Joint Dowel Bars: ASTM A 615, 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, Grade 60, plain-steel bars, ASTM A 775 epoxy coated.
- C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775.
- 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 pre-cast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
 3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
- E. Mechanical connections that develop the ACI 318-95 full tension splice strength of 125% of the specified yield strength of the reinforcing steel.

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 1 or II, gray. Do not use air entraining cement.
 2. Fly Ash: ASTM C618, Type C or F.
- B. Normal-Weight Aggregates: ASTM C 33, Class 3S. Provide aggregates from a single source for exposed concrete.
1. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
 2. Provide evidence that all aggregates are non-reactive with alkaline when tested in accordance with ASTM C 289 and C 227.
 3. Local aggregates not complying with ASTM C 33 but has shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to the Engineer.
- C. Water: ASTM C 94, clean and potable.

2.5 ADMIXTURES:

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C 494, Type A.
 2. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.
 3. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.

- C. Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

2.6 VAPOR RETARDERS:

- A. Plastic Vapor Retarder: ASTM E 1745, Class C or reinforced polyethylene sheet, ASTM D 4397, not less than 10 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.

2.7 CURING MATERIALS:

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry. No curing membranes can be used on slabs-on grade and slab above the basement.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Clean and potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

2.8 RELATED MATERIALS:

- A. Expansion and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- B. Semi-rigid Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Type A Shore Durometer hardness of 80 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Sealer for floors and vertical surfaces of masonry walls: Refer to CSI SECTION 071900 – Water Repellents.
- F. Anchoring Material: Chemical compounds of polyesters, vinylesters or epoxies used for installation of steel dowels or threaded anchor rods and inserts into new or existing concrete.

2.9 REPAIR MATERIALS:

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of underlayment manufacturer recommended for substrate conditions and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Over-layment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
 4. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.10 CONCRETE MIXTURES, GENERAL:

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
 - 1. Fly Ash: 15 percent. Not allowed in cement mixes for slab-on-grade.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions and only when approved by the Engineer.
 - 1. Use water-reducing high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - 3. Use water-reducing admixture in pumped concrete, except footings, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 - 4. Use non-chlorine accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F.
 - 5. Corrosion-inhibiting admixture for salt shed stems and piers shall contain calcium nitrite at 4 gal. per cubic yard of a 30 percent solid solution.
 - 6. No admixtures containing calcium chloride shall be permitted in slabs-on-grade and other concrete floors.

2.13 CONCRETE MIXTURES FOR BUILDING ELEMENTS:

- A. Pad Footings, Strip Footings, Pilasters/Columns and Grade Beams: Proportion normal-weight concrete mixture as follows:
 - 1. Minimum Compressive Strength: 4000 psi at 28 days.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - 3. Slump Limit: not less than 1 inch and not more than 3 inches before adding high-range water-reducing admixture or plasticizing admixture.
 - 4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
- B. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
 - 1. Minimum Compressive Strength: 4000 psi at 28 days.
 - 2. Minimum Cementitious Materials Content: 540 lb/cu. yd.
 - 3. Slump Limit: 3 inches , plus or minus 1 inch
 - 4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
 - 5. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.

2.14 FABRICATING REINFORCEMENT:

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

2.15 CONCRETE MIXING:

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, 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.
 2. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.
 3. For mixer capacity of 1 cu. yd or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixer capacity larger than 1 cu. yd, increase mixing time by 15 seconds for each additional 1 cu. yd.
 4. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK:

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 1. Class A, 1/8 inch for concrete surfaces exposed to view.
 2. Class B, 1/4 inch for other concrete surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete

surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, 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.
 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.4 VAPOR RETARDERS:

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
1. Lap joints 6 inches and seal with manufacturers 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.
1. Weld reinforcing bars according to AWS D1.4, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

- F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

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 the Engineer.
 - 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 and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 7. 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.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in CSI Division 07 Section 079200, "Joint Sealants," are indicated.
 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.7 CONCRETE PLACEMENT:

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project Site, or during placement unless approved by the Engineer.
- C. Before test sampling and placing concrete, water may be added at Project Site, subject to limitations of ACI 301.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches 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 bleed-water 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 sub-grade or on sub-grade 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 sub-grade just before placing concrete. Keep sub-grade 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 other defects. Repair tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to public view or not to be covered with a coating or covering material applied directly to concrete.
- 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, or to be covered with a coating or covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or painting.
- C. Rubbed Finish: Apply the following to smooth-formed finish and exposed-to-view concrete.
1. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part Portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white Portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
- D. 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, re-straightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While concrete is still plastic, texture the concrete surface that has been screeded, bull-floated or darbied. Use a stiff brush, broom, or rake to produce surface profile amplitude of 1/4 inch in one direction.
1. Apply scratch finish on surfaces that are indicated on the architectural plans to receive concrete floor toppings or mortar setting bed for bonded cementitious floor finishes including ceramic floor tiles, and on surfaces designed to receive penetrating liquid floor treatment and sealant.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Re-straighten, cut down high spots, and fill low spots. Repeat float passes and re-straighten until surface is left with a uniform, smooth, granular texture.
1. Apply float finish on surfaces indicated to receive trowel finish and on surfaces to be covered with fluid-applied sheet-waterproofing or built-up membrane waterproofing.
- D. Trowel Finish: After applying float-finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and re-straighten until surface is free of trowel marks and uniform in texture and appearance. Grind-

smooth any surface defects that would project through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated to be exposed to view or to be covered with resilient flooring, carpet, paint, or another thin-film-finish coating system.
 2. Finish surfaces to the following tolerances, according to ASTM E 1155 for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
 3. Finish and measure surface so that a gap at any point between concrete surface and an unlevelled, freestanding, 10-foot- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch.
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. The slab shall be uniform in appearance. The broom finish shall not dislodge aggregate nor leave large particles of cement paste which not conform to the broom finish. Coordinate required final finish with Engineer before application.

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 the plans. 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. Do not use curing membranes on slabs-on-grade and concrete floors generally in areas of etched floors.

- 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-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
 - 3. Curing 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.

- a. 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.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 CONCRETE SURFACE REPAIRS:

- A. Defective Concrete: Repair and patch defective areas when approved by the Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/4 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 Engineer.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 - 1. Repair finished surfaces containing defects. Surface defects include spalls, 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.
- E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.15 FIELD QUALITY CONTROL:

- A. Testing and Inspecting: The State will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
 1. Steel reinforcement placement.
 2. Steel reinforcement welding.
 3. Headed bolts and studs.

4. Verification of use of required design mixture.
 5. Concrete placement, including conveying and depositing.
 6. Curing procedures and maintenance of curing temperature.
 7. Verification of concrete strength before removal of shores and forms.
- 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.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143; 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.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064; 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.
 5. Compression Test Specimens: ASTM C 31.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39; 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.
 7. 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.
 8. 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 .

9. Test results shall be reported in writing to the Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Engineer.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract.

3.15 CONTRACTOR FIELD QUALITY CONTROL:

- A. Testing and Inspecting: The Contractor will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Measure floor and slab flatness and levelness according to ASTM E1155 within 48 hours of finishing.
- C. The Contractor is responsible for all corrective work necessary to meet the floor and slab flatness and levelness.

END OF SECTION 033000

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes the following:

1. Structural Steel (W Shapes, Hollow Structural Sections, Angles, Channels, Plates)
2. Non-Shrink Grout
3. High-Strength Bolts, Nuts and Washers
4. Primer

B. Related CSI Sections include the following:

1. Division 05 Section 055000, "Metal Fabrications" for steel lintels or shelf angles not attached to structural-steel frame, miscellaneous steel fabrications and other metal items not defined as structural steel.
2. Division 09 painting Sections for surface preparation and priming requirements.

1.2 DEFINITIONS:

- ##### A. Structural Steel:
- Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

1.3 PERFORMANCE REQUIREMENTS:

- ##### A. Connections:
- Provide details of connections required by the Contract to be selected or completed by structural-steel fabricator to withstand ASD-service loads indicated and comply with other information and restrictions indicated.

1. Select and complete connections using schematic details indicated and AISC's "Manual of Steel Construction, Allowable Stress Design," Part 4.

- ##### B. Construction:
- Simple framing, partially restrained.

1.4 SUBMITTALS:

- ##### A.
- Submit the following in accordance with Form 817 Article 1.20-1.05.02 and
- NOTICE TO CONTRACTOR – SUBMITTALS
- .

- ##### B. Product Data:
- For each type of product indicated.

- C. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length and type of each weld.
 - 4. Indicate type, size and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.
- D. Welding certificates.
- E. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
 - 1. Structural Steel (W-Shapes, Hollow Structural Sections, Channels, Plates and Angles) including chemical and physical properties.
 - 2. Bolts, nuts and washers including mechanical properties and chemical analysis.
 - 3. Direct-tension indicators.
 - 4. Tension-control, high-strength bolt-nut-washer assemblies.
 - 5. Anchor rods
 - 6. Anchor Rods or Bolts in chemical-anchoring material
 - 7. Shop primers.
 - 8. Shrinkage-resistant grout (Minimum Compressive Strength = 4ksi.)
- F. Source quality-control test reports.

1.5 QUALITY ASSURANCE:

- A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE for Steel-Framed Buildings.
- B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Building QMS Certification (BU).
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel."
 - 1. Present evidence that each welder has satisfactorily passed AWS qualification test for welding processes involved and, if pertinent, has undergone recertification.

E. Comply with applicable provisions of the following specifications and documents:

1. AISC, "Code of Standard Practice for Steel Buildings and Bridges."
2. AISC, "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."
3. AISC, "Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design."
4. AISC, "Specification for the Design of Steel Hollow Structural Sections."
5. AISC, "Specification for Allowable Stress Design of Single-Angle Members."
6. RCSC, "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.6 DELIVERY, STORAGE AND HANDLING:

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.

1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
2. Do not store materials on structure in a manner that might cause distortion, damage or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.7 COORDINATION:

A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS:

- A. W-Shapes (Beams and Columns): ASTM A992 (50 ksi.)
- B. Hollow Structural Sections (Columns): ASTM A500, Grade C (50 ksi.)
- C. Channels, Angles, Plates: ASTM A36.
- D. Bars: ASTM A36.
- E. Steel Pipe: ASTM A53, Type E, Grade B or ASTM A106
 1. Weight Class: Standard.
 2. Finish: Galvanized.

- F. Medium-Strength Steel Castings: ASTM A27, Grade 65-35, carbon steel.
- G. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS AND ANCHORS:

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
 - 1. Finish: Plain.
 - 2. Direct-Tension Indicators: ASTM F 959, Type 325 compressible-washer type.
 - a. Finish: Plain.
- B. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy hex head steel structural bolts with splined ends; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
 - 1. Finish: Plain.
- C. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.
- D. Sleeve Nuts: ASTM A 108, Grade 1018, cold-finished carbon steel.

2.3 PRIMER:

- A. Zinc silicate conforming to M.07.17 of "Form 816", except that the resistance tests of Subarticle 4 are not mandatory.

2.4 GROUT:

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, non-corrosive, non-staining, mixed with water to a consistency suitable for application and a 30-minute working time. (Minimum Compressive Strength of 4 ksi.)

2.5 FABRICATION:

- A. Structural Steel: Fabricate and assemble in shop to the fullest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design."
 - 1. Camber structural-steel members where indicated.

2. Identify high-strength structural steel according to ASTM A6/6M and maintain markings until structural steel has been erected.
 3. Mark and match-mark materials for field assembly.
 4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. If not shown in the Contract Drawings, design the connections in simply-supported spans to be able to carry one-half of the uniform load capacity of the beam at the specified span shown in the tables of Uniform Load Constants, in Part 2 of the AISC Manual of Steel construction (ASD)- 9th Edition. Do not use one-sided or other types of eccentric connections for the attachments of main structural members.
- C. Thermal Cutting: Perform thermal cutting by machine to the fullest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
- D. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- F. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10 inches o.c., unless otherwise indicated.
- G. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
1. Cut, drill or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 2. Base-Plate Holes: Cut, drill, mechanically-thermal-cut or punch holes perpendicular to steel surfaces.
 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS:

- A. High-Strength Bolts: Shop-install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug-tightened and Slip-critical.

- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance and quality of welds and for methods used in correcting welding work.
1. Remove backing bars or runoff tabs, back gouge and grind steel smooth.
 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
 3. Verify that weld sizes, fabrication sequences and equipments used for architecturally-exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.7 SHOP PRIMING:

- A. Shop-prime steel surfaces except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Surfaces to be field welded.
 3. Surfaces to be high-strength bolted with slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials.
 5. Galvanized surfaces.
- B. Comply with the provisions of Form 816, Article M.07 except as otherwise stated in this specification and with the painting system as specified in CSI Division 09 painting Sections. Shop-paint structural steel, except those members or portions of members to be embedded in concrete or mortar or scheduled to receive sprayed-on fireproofing. Paint embedded steel that is partially exposed on exposed portions and initial 2 inches of embedded areas only.
- C. All structural steel except as indicated shall be shop-painted with a zinc silicate primer conforming to Form 816, Article M.07.17, except that the resistance tests of Sub-article 4 are not mandatory.
- D. Shop-painting shall conform to the requirements of Form 816, Article 6.03.03-37, except as indicated within this part of the specifications and with the painting system as specified in CSI Division 09 painting Sections.
- E. Field-painting shall conform to the requirements of Form 816, Article 6.03.03-38, except as indicated within this part of the specifications and with the painting system as specified in CSI Division 09 painting Sections.

- F. Steel to steel contact surfaces welded in the shop shall be cleaned but not painted before welding occurs.
- G. For all slip-critical connections used, the steel to steel contact surfaces shall not be painted.
- H. Parts not in contact but inaccessible after assembly shall be painted before assembly with two coats of shop paint, the second coat to match the system of the finish painting of steel as specified in CSI Division 09 painting Sections. The colors shall be coordinated with approved submittals.
- I. Before painting, all structural steel shall be blast-cleaned in conformance with Form 816, Article 6.03.03-24.
 - 1. All fins, tears, slivers and burred or sharp edges that are present on any steel member or that appear during the blasting operation shall be removed by grinding and the area re-blasted to give a 2-3 mil surface profile.
- J. The ambient air and surface temperatures shall be at least 5°F above the dewpoint prior to and during coating applications.

2.8 GALVANIZING:

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123.
 - 1. Fill vent holes and grind smooth after galvanizing.
 - 2. Galvanize lintels and shelf angles attached to structural-steel frame and located in exterior walls.

2.9 SOURCE QUALITY CONTROL:

- A. The Engineer will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
 - 2. Provide the Department 7 Calendar-day Notice for steel fabrication in Connecticut, and 10 Calendar-day Notice for all out-of-state fabrication.
- B. Correct deficiencies in Work that test reports and inspections indicate do not comply with the Contract.
- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."

- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
1. Liquid Penetrant Inspection: ASTM E165.
 2. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 3. Ultrasonic Inspection: ASTM E164.
 4. Radiographic Inspection: ASTM E94.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Verify elevations of concrete and masonry bearing surfaces and locations of anchor rods, bearing plates and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION:

- A. Provide temporary shores, guys, braces and other supports during erection to keep structural steel secure, plumb and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections and bracing are in place, unless otherwise indicated.
 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION:

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design."
- B. Base and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 1. Set base and bearing plates for structural members on wedges, shims or setting nuts as required.
 2. Weld plate washers to top of base plate.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
 4. Promptly pack grout solidly between bearing surfaces and base plates to eliminate any voids. Neatly finish exposed surfaces, protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel and architecturally-exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure.
 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Remove erection bolts on architecturally-exposed structural steel. Fill holes with plug welds and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection.
- H. Do not enlarge deficient holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS:

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened and Slip-critical, as indicated.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment and removal of paint on surfaces adjacent to field welds.
 2. Remove backing bars or run-off tabs, back gouge, and grind steel smooth.

3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
4. Verify that weld sizes, fabrication sequences and equipments used for architecturally-exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.5 FIELD QUALITY CONTROL:

- A. Testing Agency: The Engineer will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A325 or A490 Bolts."
- C. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
 1. In addition to visual inspection, field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165.
 - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E164.
 - d. Radiographic Inspection: ASTM E94.
- D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract.

3.6 REPAIRS AND PROTECTION:

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A780 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 and accessories, bearing plates and abutting structural steel.
 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.

- C. Touchup Painting: Cleaning and touchup painting are specified in CSI Division 09 painting Sections.

END OF SECTION 051200

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes the following:

1. Steel framing and supports for mechanical and electrical equipment.
2. Steel framing and supports for applications where framing and supports are not specified in other Sections.
3. Steel framing and supports for movable wall systems.
4. Steel weld plates and angles for casting into concrete not specified in other Sections.
5. Stainless steel framing at raised floor system.

B. Products furnished, but not installed, under this Section include the following:

1. Anchor bolts, steel pipe sleeves and wedge-type inserts indicated to be cast into concrete.

C. Related CSI Sections include the following:

1. Division 03 Section 033000, "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into concrete.
2. Division 05 Section 051200, "Structural Steel Framing."
3. Division 06 Section 061000, "Rough Carpentry" for metal framing anchors.

1.2 PERFORMANCE REQUIREMENTS:

- A. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1.3 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR-SUBMITTALS.

B. Product Data: For the following:

1. Paint products.
2. Grout.
3. Drilled-In Anchors.
5. Materials used in miscellaneous metal fabrications.

C. Shop Drawings: Show fabrication and installation details for metal fabrications.

1. Include plans, elevations, sections and details of metal fabrications and their connections. Show anchorage and accessory items.
2. Provide templates for anchors and bolts specified for installation under other Sections.
3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Quality Assurance Submittals

1. Welding Certificates.
2. Qualification Data: For Professional Engineer.

1.4 QUALITY ASSURANCE:

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.6, "Structural Welding Code--Stainless Steel."
5. Certify that each welder has satisfactorily passed AWS qualification test for welding process involved and, if pertinent, has undergone recertification.

1.5 PROJECT CONDITIONS:

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications 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 dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1.6 COORDINATION:

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts and items with integral anchors that are to be embedded in concrete or masonry. Deliver such items to Project Site in time for installation.
- B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project Site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

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

2.2 METALS, GENERAL:

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names or blemishes.

2.3 FERROUS METALS:

- A. Steel Plates, Shapes and Bars: ASTM A 36.
- B. Stainless-Steel Bars and Shapes: ASTM A 276, Type
- C. Stainless Steel Materials:
 - 1. Bar Stock: ASTM A 276, Type 302 or 304
 - 2. Plate: ASTM A 666, Type 302 or 304
- D. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

2.4 FASTENERS:

- A. General: Unless otherwise indicated, provide Type 304 and Type 316 for corrosive environment, stainless-steel fasteners for exterior use and zinc-plated fasteners with

coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade and class required.

- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and where indicated, flat washers.
- C. Anchor Bolts: ASTM F 1554, Grade 36
 - 1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.
- D. Eyebolts: ASTM A 489
- E. Machine Screws: ASME B18.6.3
- F. Lag Bolts: ASME B18.2.1
- G. Wood Screws: Flat head, ASME B18.6.1
- H. Plain Washers: Round, ASME B18.22.1
- I. Lock Washers: Helical, spring type, ASME B18.21.1
- J. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers and shims as needed, hot-dip galvanized per ASTM A 153.
- K. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material for Anchors in Exterior Locations: Alloy Group 1 (A1) or 2 (A4) stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.

2.5 MISCELLANEOUS MATERIALS:

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

- B. Shop Primers: Comply with Form 816, Section M.07.17, except that the resistance test of Subarticle 4 shall not be mandatory.
 - 1. Use primer with a VOC content that complies with local regulations.
 - 2. Available Products:
 - a. Benjamin Moore & Co.; Epoxy Zinc-Rich Primer CM18/19.
 - b. Carboline Company; Carbozinc 621.
 - c. ICI Devoe Coatings; Catha-Coat 313.
 - d. International Coatings Limited; Interzinc 315 Epoxy Zinc-Rich Primer.
 - e. PPG Architectural Finishes, Inc.; Aquapon Zinc-Rich Primer 97-670.
 - f. Sherwin-Williams Company (The); Corothane I GalvaPac Zinc Primer.
 - g. Tnemec Company, Inc.; Tneme-Zinc 90-97.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel, complying with SSPC-Paint 20.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Non-shrink, Non-metallic Grout: Factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- F. Concrete Materials and Properties: Comply with requirements in CSI Division 03 Section 033000, "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 4000 psi, unless otherwise indicated.

2.6 FABRICATION, GENERAL:

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural strength and integrity of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion-resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and the contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill and tap metal fabrications as indicated to receive finish hardware, screws and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 F, material surfaces.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS:

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill and tap units to receive hardware, hangers and similar items.
1. Fabricate units from slotted channel framing where indicated.
 2. Furnish inserts if units are installed after concrete is placed.
- C. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Provide bearing plates welded to beams where indicated.
 2. Drill girders and plates for field-bolted connections where indicated.
 3. Where wood nailers are attached to girders with bolts or lag screws, drill holes at 24 inches o.c.
- D. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel base plates and top plates as indicated. Drill base plates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness, unless otherwise indicated.
1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
 2. Unless otherwise indicated, provide 1/2-inch base plates with four 5/8-inch anchor bolts and 1/4-inch top plates.
- E. Galvanize miscellaneous framing and supports where indicated.

2.8 STEEL WELD PLATES AND ANGLES:

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

2.9 MISCELLANEOUS STEEL TRIM:

- A. Unless otherwise indicated, fabricate units from steel shapes, plates and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings and anchorages as needed to coordinate assembly and installation with other work.
1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim and interior miscellaneous steel trim, where indicated.

2.10 FINISHES, GENERAL:

- A. Comply with CSI Division 09 painting Sections.
- B. Finish metal fabrications after assembly.

2.11 STEEL AND IRON FINISHES:

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 123, for galvanizing steel and iron products.
 - 2. ASTM A 153, for galvanizing steel and iron hardware.
- B. Preparation for Shop Priming: Comply with Form 816, Article 6.03.03-24 modified as follows:
 - 1. Add: "Remove by grinding, all fins, tears, slivers and burred or sharp edges that are present on any steel member or that appear during the blasting operation and re-blast the area to give a 2 mil surface profile."

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL:

- A. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment and elevation; with edges and surfaces level, plumb, true and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry or similar construction.

- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood or dissimilar metals with a heavy coat of bituminous paint.

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS:

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for operable partitions securely to and rigidly brace from building structure.
- C. Support steel girders on solid grouted masonry, concrete or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
 - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in Part 3.3 "Installing Bearing and Leveling Plates".
- D. Install pipe columns on concrete footings with grouted base plates. Position and grout column base plates as specified in Part 3.3 "Installing Bearing and Leveling Plates".
 - 1. Grout base plates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLING BEARING AND LEVELING PLATES:

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use non-shrink, non-metallic grout in exposed locations, unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING:

- A. Touchup Painting: Comply with Section M.07 of Form 816 except as otherwise indicated.
- B. Finish Painting: Comply with CSI Division 09 painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

SECTION 055213 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes, but is not limited to the following:
 - 1. Wall mounted handrails.
 - 2. Exterior post guardrails.

1.2 REFERENCE STANDARDS

- A. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2007.
- B. ASTM E 935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings; 2000 (Reapproved 2006).
- C. ASTM E 985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings; 2000 (Reapproved 2006).

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR-SUBMITTALS.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Handrails and Railings: Custom fabrications utilizing styles, shapes and fabrications noted on the drawings and meeting the performance standards noted in this specification; provide one of the following manufacturers noted below, or an approved equal.
 - 1. C. R. Laurence Co., Inc: www.crlaurence.com.
 - 2. Kee Safety, Inc; Kee Klamp (steel): www.keesafety.com.
 - 3. Sterling Dula Architectural Products: www.sterlingdula.com.
 - 4. The Wagner Companies: www.wagnercompanies.com.

2.2 RAILINGS - GENERAL REQUIREMENTS

- A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of ASTM E 985 and applicable local code.

- B. Design railing assembly, wall rails, and attachments to resist lateral force of 75 lbs minimum per linear foot applied in any direction at the top and to transfer this load through the supports to the structure. Handrails and guards shall be able to resist a single concentrated load of 200 lbs, applied in any direction at any point along the top, and to transfer this load through the supports to the structure without damage or permanent set. Test in accordance with ASTM E 935.
- C. Allow for expansion and contraction of members and building movement without damage to connections or members.
- D. Dimensions: See drawings for configurations and heights.
- E. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
 - 1. For anchorage to concrete, provide inserts to be cast into concrete, for bolting anchors.
 - 2. Posts: Provide adjustable flanged brackets.
- F. Provide steel railing system at interior applications unless otherwise noted.
- G. Provide aluminum railing system at exterior applications unless otherwise noted.

2.3 STEEL RAILING SYSTEM

- A. Steel Tube: ASTM A 500, Grade b cold-formed; ASTM A 501 hot-formed; or structural tubing.
- B. Steel Pipe: ASTM A 53/A 53M Schedule 40 paint finish see CSI Division 09 painting specifications for recommended finish for steel.
- C. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.
- D. Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.
- E. Straight Splice Connectors: Steel: see contract drawings.

2.4 FABRICATION

- A. Accurately form components to suit specific project conditions and for proper connection to building structure.
- B. Fit and shop assemble components in largest practical sizes for delivery to site.

- C. Fabricate components with joints tightly fitted and secured.
- D. Welded Joints:
 - 1. Interior Components: Continuously seal joined pieces by continuous welds.
 - 2. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

2.5 FINISHES

- A. Touch-Up materials: As recommended by coating manufacturer for field application.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions (by Installer): Examine conditions under which Pipe and Tube Railings are to be installed in coordination with Installer of materials and components specified in this Section and notify the Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Inspection: Prior to start of erection, check location of walls, adequate backing materials are present, plumb and level, floor slab conditions and level, embedded anchor bolts, plates, angles, etc.

3.2 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be embedded in masonry with setting templates, for installation as work of other sections.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.
- C. Anchor railings securely to structure.
- D. Field weld anchors as indicated on shop drawings. Touch-up welds with primer. Grind welds smooth.

- E. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

3.4 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per floor level, non-cumulative.
- B. Maximum Offset From True Alignment: 1/16 inch.
- C. Maximum Out-of-Position: 1/16 inch.

3.5 ADJUSTING / CLEANING / PROTECTION

- A. After completion of work, remove all containers and debris resulting from installation and clean or repair adjacent surfaces damaged by work procedures.
- B. Protect surfaces from damage after work is complete.
- C. Repair any damage caused by work activities.

END OF SECTION

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes the following:

1. Framing with dimension lumber.
2. Concealed wood blocking, nailers and support.
3. Communications and electrical room mounting boards
4. Miscellaneous wood nailers, furring, and grounds.

1.2 DEFINITIONS:

A. Exposed Framing: Framing not concealed by other construction.

B. Dimension Lumber: Lumber of 2 inches nominal or greater, but less than 5 inches nominal in least dimension.

C. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.

1.3 SUBMITTALS:

A. Submit the following in accordance with Form 817, Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. 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 materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated the materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. Fire-retardant treatments specified to be High-Temperature (HT) type, include physical properties of treated lumber both before and after exposure to elevated

- temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
 5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
- C. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- D. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
1. Power-driven fasteners.
 2. Powder-actuated fasteners.

1.4 QUALITY ASSURANCE:

- A. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria":
1. Dimension lumber framing.
 2. Miscellaneous lumber.

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.

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 DIMENSION LUMBER FRAMING:

- A. Maximum Moisture Content: 15 percent for 2-inch nominal thickness or less, and 19 percent for more than 2-inch nominal thickness.
- B. Miscellaneous Framing: Douglas Fir Larch (North) of No.1, No. 2 or better grade, with minimum Allowable Stress Capacities and Modulus of Elasticity as indicated on the plans.

2.3 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. Furring
 4. Grounds
- B. 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.
- C. For items of dimension lumber, provide Douglas Fir Larch (North), No.1 grade, with 15 percent maximum moisture content.
- D. For blocking and nailer used for attachment of other construction. Select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.4 PLYWOOD BACKING PANELS:

- A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

2.5 FASTENERS:

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL:

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's WCD 1 "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.
- F. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities.
- G. 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.
- H. Comply with AWWPA 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.
- I. Securely attach rough 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.
- J. 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.

- K. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

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. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- C. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
- D. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- E. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- F. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- G. Specifically, provide the following non-structural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Wall brackets.
 - 3. Grab bars.
 - 4. Towel and bath accessories.

3.3 SOFFIT-RELATED CARPENTRY

- A. Coordinate installation of carpentry with all construction and framing of soffit openings.

3.4 INSTALLATION OF CONSTRUCTION PANELS

- A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.

2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
3. Install adjacent boards without gaps.
4. Size and Location: As indicated on drawings.
5. All construction panels shall be painted white or as indicated.

3.5 WOOD FURRING INSTALLATION:

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

3.6 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 061000

SECTION 068200 – FIBERGLASS REINFORCED PLASTIC PRODUCTS

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Glass-fiber reinforced plastic (FRP) wall paneling and trim accessories at exterior column.

1.2 COORDINATION:

- A. Coordinate installation of anchorages for enclosures. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation.

1.3 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For the following:
 1. Glass-fiber-reinforced-plastic enclosures.
- C. Shop Drawings of structural support members, and enclosure construction shall be submitted to the Engineer for approval. Working Drawings shall include, but not limited to the following:
 1. Plans, elevations, sections, details, with dimensions of the enclosures and structural members and attachments to other work.
 2. Size and type of supporting frames or framework required.
- D. Samples: For plastic paneling and trim accessories. Samples shall be of same color as finished work. Construct sample panel to include typical connections, fasteners and any embedded connections.
- E. Quality Assurance Submittals
 1. Certification of Compliance with V.O.C. Regulations: Submit Certification by manufacturer that products supplied comply with Regulations controlling use of volatile organic compounds (VOCs).
 2. Installer Qualification: Fabricator of products.

1.4 QUALITY ASSURANCE

- A. The FRP manufacturer shall be one who is currently in the business of manufacturing and supplying architectural FRP components to the building construction industry. The manufacturer shall have been engaged in such activities for a minimum of five (5) years and have produced materials for projects comparable in size, scope, detail and complexity to this project.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.

1.5 FIELD CONDITIONS:

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with enclosure by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS:

- A. Attachments
 - 1. Attachment accessories, support brackets, angles, anchor bolts and mounting bolts shall be ANSI Type 316 stainless steel, fiber glass, or provide a zinc coating.

2.2 PLASTIC SHEET PANELING

- A. General: Gelcoat-finished, glass-fiber reinforced plastic panels complying with ASTM D 5319.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings by Edon Corporation or approved equal product by one of the following:
 - a. Architectural Fiberglass, Inc.
 - b. STM Industries.
 - c. Fiberglass Specialties, Inc.
 - 2. Nominal Thickness: Not less than 0.12 inch
 - 3. Surface Finish: Smooth.
 - 4. Gel-Coat: High Performance Product with ultraviolet inhibitors
 - a. Color: Custom to match adjacent existing concrete column construction.

2.3 ACCESSORIES

- A. Trim Accessories: Manufacturer's standard one-piece vinyl extrusions designed to retain and cover edges of panels. Provide division bars, inside corners, outside corners, and caps as needed to conceal edges.
 - 1. Color: Match panels.
- B. Adhesives and Sealants: Adhesives and sealants are certified for low VOCs by the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," include 2004 Addenda or are certified as low VOC by one of the following:
 - 1. Scientific Certification Systems – Indoor Advantage-Gold
 - 2. GREENGUARD Certification Program
 - 3. Green Seal GS-36 (adhesives and sealants)
- C. Adhesive: As recommended by plastic paneling manufacturer.
- D. Sealant: Single-component, mildew-resistant, neutral-curing silicone sealant recommended by plastic paneling manufacturer and complying with requirements in Division 07 Section "Joint Sealants."
- E. Hardware and Fasteners: Provide all metal hardware and fasteners, both loose and embedded. Hardware and fasteners shall be stainless steel only.

2.4 ENCLOSURE AND SUPPORTS:

- A. General: Fabricate custom glass-fiber-reinforced-plastic enclosure form and profiles indicated and as necessary to receive gratings. Miter connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
 - 1. Resin: Polyester with a UV inhibitor.
 - a. Flame-Spread Index: 25 or less when tested according to ASTM E 84.
 - 2. Color: Manufacturer's standard grey, color match existing adjacent concrete column.

2.5 FABRICATION:

- A. Shop Assembly: Shop fabricate grating sections to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

- C. Form enclosure support from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form joints.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
- F. Fabricate cutouts in enclosure for penetrations indicated. Arrange cutouts to permit access to piping routing within enclosure without disturbing items penetrating enclosure.
- G. After fabrication, all cut ends, holes and abrasions of glass-fiber-reinforced-plastic products shall be sealed with a compatible resin coating to prevent intrusion of moisture.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that could impair bond of adhesive, including oil, grease, dirt, and dust.
- B. Condition panels by unpacking and placing in installation space before installation according to manufacturer's written recommendations.
- C. Lay out paneling before installing. Locate panel joints where indicated.

3.2 INSTALLATION, GENERAL:

- A. Install plastic paneling according to manufacturer's written instructions.
- B. Install panels in a full spread of adhesive.
- C. Install trim accessories with adhesive and stainless steel fasteners. Exposed fasteners to be located in reveals only.
- D. Fill grooves in trim accessories with sealant before installing panels and bed inside corner trim in a bead of sealant.
- E. Maintain uniform space between panels and adjacent construction. Fill space with sealant.
- F. Remove excess sealant and smears as paneling is installed. Clean with solvent recommended by sealant manufacturer and then wipe with clean dry cloths until no residue remains.

END OF SECTION 068200

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Concealed building sound retardant semi-rigid batt insulation for noise control.
 - 2. Spray foam for filling window and door shim spaces in interior walls.
 - 3. Vapor Retarders below the concrete slab infill areas.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - 2. ASTM C 665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2006.
 - 3. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2008.
 - 4. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- A. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
- B. Quality Assurance Submittals:
 - 1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.4 QUALITY ASSURANCE

- A. Single Source Responsibility: Furnish each insulation type from one manufacturer for entire Project, unless otherwise acceptable to Designer.
- B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for the installation of closed-cell spray polyurethane foam insulation.

- B. 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.
- C. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Surface-Burning Characteristics: ASTM E 84.
 - 2. Fire-Resistance Ratings: ASTM E 119.
 - 3. Combustion Characteristics: ASTM E 136.
- D. FM-Global Requirements: Use non-combustible or FM Approved Class 1 insulating materials including wall and floor insulation, spray applied closed cell polyurethane foam insulation, sound attenuation insulation, and all board, batt, and blanket insulation. Use all products within the limits of their FM Approval. FM Approved materials are required to have the Approval mark on the packaging or the material itself. Materials without proper labeling are not FM Approved; do not treat them as such. Use FM Global Property Loss Prevention Data Sheet 1-57, Plastics in Construction, for guidance.

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.

PART 2 - PRODUCTS

2.1 INSULATING MATERIALS

- A. General: Provide insulating materials that comply with requirements and with referenced standards and, for preformed units, in sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths, and lengths.
- B. Insulation Materials: Use of chlorofluorocarbons (CFCs) not allowed.
- C. Sound-Control Blankets: Glass fibers and resinous binders formed into un-faced flexible blankets; complying with requirements of ASTM C 665 for Type I insulation and following:
 - 1. Flame spread (ASTM E84): less than 75

2. UL listed
3. Basis of Design: Based on following products:
 - a. Sound-Control Blanket:
 - 1) “Sound Attenuation Batts Fiber Glass” by Owens Fiberglass Corp.
 - 2) “Sound Control Batts” by Johns Manville Corp.,
 - 3) “CentraPro AcoustaTherm Batts” by Certain-Teed Corp.

2.2 VAPOR RETARDERS

- A. Vapor Barrier below slab on grade must have the following qualities:
 1. Permeance: ASTM E 1249 0.012 perms or lower
 2. Water Vapor Barrier: ASTM E 1745 Meets Class A (Plastics)
- B. Vapor Barrier Manufacturers:
 1. As a basis of design, details and specifications have been based on following products or approved equal:
 - a. Stego Wrap (15 mil) Vapor Barrier by Stego Industries LLC
 - b. Pre-moulded Membrane with PLASMATIC CORE by W.R. Meadows
 - c. Zero Perm by Alumiseal
- C. Accessories
 1. Seam Tape
 - a. Tape must have the following qualities:
 - 1) Water Vapor Transmission Rate ASTM E 1249, 0.3 perms or lower
 - b. Seam Tape
 - 1) Similar to Stego Tape by Stego Industries LLC or approved equal.
 2. Vapor Proofing Mastic
 - a. Mastic must have the following qualities:
 - 1) Water Vapor Transmission Rate ASTM E 1249, 0.3 perms or lower
 - b. Mastic
 - 1) Similar to Stego Mastic by Stego Industries LLC or approved equal.
- D. Preparation
 1. Level and tamp or roll aggregate, sand or tamped earth base.
- E. Installation
 1. Install Vapor Barrier/Retarder:
 - a. Installation shall be in accordance with manufacturer’s instructions.
 - b. Overlap joints 6 inches and seal based on manufacturer’s requirements.
 - c. Seal all penetrations (including pipes) per manufacturer’s instructions.
 - d. No penetration of the Vapor Barrier/Retarder is allowed except for reinforcing steel and permanent utilities.
 - e. Repair damaged areas by using patches provided by Vapor Barrier/Retarder manufacturer.

- F. Vapor-Retarder Fasteners: Utilize product approved by vapor barrier manufacturer for fastening and seaming the system. Comply with manufacturer's installation requirements.
- G. Single-Component Non-sag Sealant: Utilize product approved by vapor barrier manufacturer for the system to seal around perimeter edges and terminations of dissimilar materials. Comply with manufacturer's installation requirements.

2.3 AUXILIARY INSULATING MATERIALS

- A. Spray Applied Filler Foam Products, include but are not limited to the following:
 - 1. Low Pressure Filler Foam around the perimeter openings of door frames, and general openings (tested in accordance with AAMA 812). Product for reducing air and sound infiltration. Complies with ASTM C 1620, for foam sealants.
 - a. CF-AS CJP All Seasons Crack & Joint Insulating Foam
 - b. Provide Low Pressure Filler Foam around the perimeter openings of window, door frames, and general openings (tested in accordance with AAMA 812). Product for reducing air, sound, dirt, and water infiltration. Complies with ASTM C 1620, for foam sealants.
 - c. The product shall be VOC compliant.
 - d. The product shall not contain formaldehyde.
 - 1) As a basis of design provide product similar to: CF 812 Window & Door Pro, by Hilti or approved equal.
- B. Spray Foam Products:
 - 1. Provide general use spray foam to where noted:
 - a. Provide a closed cell spray foam product similar to BASF "Comfort Foam" or approved equal where noted on drawings at top of wall and concealed conditions. Provide protection of foam in accordance with code requirements. Comply with ASTM requirements and installation methods required by the manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Clean substrates of substances harmful to insulations or vapor barriers, including removal of projections, which might puncture vapor barriers.

- C. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation and adhesive.

3.2 PREPARATION

- A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.3 INSTALLATION

- A. Comply with insulation manufacturer's written instructions applicable to products and application 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 in thickness indicated 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. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.
- E. For preformed insulating units, 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.

3.4 VAPOR BARRIER GENERAL

- A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- B. Firmly attach vapor retarders to 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 retarder.
- D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.

3.5 INSTALLATION OF GENERAL BUILDING INSULATION

- 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. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
- C. Set vapor-retarder-faced units with vapor retarder to warm-in-winter side in location indicated of construction, unless otherwise indicated.
 - 1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

3.6 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 078100 - APPLIED FIREPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes sprayed fire-resistive materials.

1.2 DEFINITIONS

- A. SFRM: Sprayed fire-resistive materials.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
- C. Shop Drawings: Framing plans or schedules, or both, indicating the following:
 - 1. Extent of fireproofing for each construction and fire-resistance rating.
 - a. Existing structural columns shall maintain a 2hr rating.
 - b. Existing cellular metal decking shall maintain a 2hr rating.
- D. Qualification Data: For Installer and testing agency.
- E. Product Certificates: For each type of fireproofing.
- F. Evaluation Reports: For fireproofing, from ICC-ES.
- G. Preconstruction Test Reports: For fireproofing.
- H. Field quality-control reports.
- I. Quality Assurance Submittals:
 - 1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 44 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- B. Ventilation: Ventilate building spaces during and after application of fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Assemblies: Provide fireproofing, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.
- B. Source Limitations: Obtain fireproofing for each fire-resistance design from single source.
- C. Fire-Resistance Design: Tested according to ASTM E 119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Steel members are to be considered unrestrained unless specifically noted otherwise.
- D. VOC Content: Applied sealer and topcoat products shall comply with VOC content limits of authorities having jurisdiction.

2.2 SPRAYED FIRE-RESISTIVE MATERIALS

- A. Sprayed Fire-Resistive Material: Manufacturer's standard, factory-mixed, lightweight, dry formulation, complying with indicated fire-resistance design, and conveyed in a dry state and mixed with atomized water at place of application.

1. Available Products: Subject to compliance with requirements, available products that may be incorporated into the Work are limited to the following:
 - a. CAFCO Blaze Shield by Isolatek International.
2. "Or Equal" products will not be considered for this project due to the need to match the existing fireproofing
3. Bond Strength: Minimum 150-lbf/sq. ft. cohesive and adhesive strength based on field testing according to ASTM E 736.
4. Density: Not less than density specified in the approved fire-resistance design, according to ASTM E 605.
5. Thickness: As required to match the existing fire-resistance design indicated, measured according to requirements of fire-resistance design or ASTM E 605, whichever is thicker, but not less than 0.375 inch.
6. Combustion Characteristics: ASTM E 136.
7. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 10 or less.
 - b. Smoke-Developed Index: 10 or less.
8. Compressive Strength: Minimum 10 lbf/sq. in. according to ASTM E 761.
9. Corrosion Resistance: No evidence of corrosion according to ASTM E 937.
10. Deflection: No cracking, spalling, or delamination according to ASTM E 759.
11. Effect of Impact on Bonding: No cracking, spalling, or delamination according to ASTM E 760.
12. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. in 24 hours according to ASTM E 859.
13. Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G 21.
14. Finish: Match existing finish.

2.3 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that are compatible with fireproofing and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- B. Substrate Primers: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:
 1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance

Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E 736.

- C. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.
- D. Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by fireproofing manufacturer.
- E. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by fireproofing manufacturer. Include pins and attachment.
- F. Topcoat: Suitable for application over applied fireproofing; of type recommended in writing by fireproofing manufacturer for each fire-resistance design.
 - 1. Cement-Based Topcoat: Factory-mixed, cementitious hard-coat formulation for trowel or spray application over SFRM.
 - 2. Water-Based Permeable Topcoat: Factory-mixed formulation for brush, roller, or spray application over applied SFRM. Provide application at a rate of 30 sq. ft./gal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design.
 - 1. Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of fireproofing with substrates under conditions of normal use or fire exposure.
 - 2. Verify that objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
 - 3. Verify that substrates receiving fireproofing are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fireproofing application.
- B. Conduct tests according to fireproofing manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.

- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Cover other work subject to damage from fallout or overspray of fireproofing materials during application.
- B. Clean substrates of substances that could impair bond of fireproofing.
- C. Prime substrates where included in fire-resistance design and where recommended in writing by fireproofing manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fireproofing.
- D. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fireproofing. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

3.3 APPLICATION

- A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.
- B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.
 - 1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
 - 2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.
- D. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.

- E. Spray apply fireproofing to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.
- F. Extend fireproofing in full thickness over entire area of each substrate to be protected.
- G. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.
- H. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fireproofing that differs in color from that of encapsulant over which it is applied.
- I. Where sealers are used, apply products that are tinted to differentiate them from fireproofing over which they are applied.
- J. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.
- K. Cure fireproofing according to fireproofing manufacturer's written instructions.
- L. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.
- M. Finishes: Where indicated, apply fireproofing to produce the following finishes:
 - 1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.
 - 2. Spray-Textured Finish: Finish left as spray applied with no further treatment.
 - 3. Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.
 - 4. Skip-Troweled Finish: Even leveled surface produced by troweling spray-applied finish to smooth out the texture and neaten edges.
 - 5. Skip-Troweled Finish with Corner Beads: Even, leveled surface produced by troweling spray-applied finish to smooth out the texture, eliminate surface markings, and square off edges.

3.4 CLEANING, PROTECTING, AND REPAIRING

- A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.
- B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing is without damage or deterioration at time of Substantial Completion.

- C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.
- D. Repair fireproofing damaged by other work before concealing it with other construction.
- E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 078100

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items.
- B. Related CSI Sections include the following:
 - 1. Division 22 and 23 Sections specifying duct and piping penetrations.
 - 2. Division 26, 27, and 28 Sections specifying cable and conduit penetrations.

1.2 PERFORMANCE REQUIREMENTS:

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 - 1. Fire-resistance-rated walls including fire walls, fire partitions.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:
 - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - 2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
 - a. Penetrations located outside wall cavities.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 - 2. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.3 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For each through-penetration firestop system, show each type of construction condition penetrated, relationships to adjoining construction, and type of penetrating item. Include firestop design designation of qualified testing and inspecting agency that evidences compliance with requirements for each condition indicated.
 - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.
 - 2. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular through-penetration firestop condition, submit illustration, with modifications marked, approved by through-penetration firestop system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
- D. Quality Assurance Submittals:
 - 1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.
- E. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
 - 1. Types of penetrating items.
 - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
 - 3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
 - 4. Qualification Data: For Installer.
 - 5. Product Certificates: For through-penetration firestop system products, signed by product manufacturer.
 - 6. Product Test Reports: From a qualified testing agency indicating through-penetration firestop system complies with requirements, based on comprehensive testing of current products.

1.4 QUALITY ASSURANCE:

- A. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."
- B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
- C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.
- D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1.2, "Performance Requirements":
 - 1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 - 2. Through-penetration firestop systems are identical to those tested per testing standard referenced in Part 1.2 "Performance Requirements." Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
 - 1) UL in its "Fire Resistance Directory."

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life if applicable, qualified testing and inspecting agency's classification marking applicable to Project, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.6 PROJECT CONDITIONS:

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.7 COORDINATION:

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- C. Notify Engineer's inspecting agency at least seven calendar days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, through-penetration firestop systems that may be incorporated into the Work include, but are not limited to, those systems indicated that are produced by one of the following manufacturers:
 - 1. A/D Fire Protection Systems Inc.
 - 2. Grace, W. R. & Co. - Conn.
 - 3. Hilti, Inc.
 - 4. Johns Manville.
 - 5. Nelson Firestop Products.
 - 6. NUCO Inc.
 - 7. RectorSeal Corporation (The).
 - 8. Specified Technologies Inc.
 - 9. 3M; Fire Protection Products Division.
 - 10. Tremco; Sealant/Weatherproofing Division.
 - 11. USG Corporation.

2.2 FIRESTOPPING, GENERAL:

- A. Compatibility: Provide through-penetration firestop systems that are compatible with one another; with the substrates forming openings; and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag-/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 - 2. Temporary forming materials.
 - 3. Substrate primers.
 - 4. Collars.
 - 5. Steel sleeves.

2.3 FILL MATERIALS:

- A. General: Provide through-penetration firestop systems containing the types of fill materials required. Fill materials are those referred to in directories of referenced testing and inspecting agencies as "fill," "void," or "cavity" materials.
- B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture.
- D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

- F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- H. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- I. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives.
- J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- K. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and other surfaces requiring a nonslumping, gunnable sealant, unless indicated firestop system limits use to nonsag grade for both opening conditions.
 2. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
 3. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

2.4 MIXING:

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of work.

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

3.2 PREPARATION:

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with firestop system manufacturer's written instructions and with the following requirements:
 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION:

- A. General: Install through-penetration firestop systems to comply with Part 1.2 "Performance Requirements," and with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 FIELD QUALITY CONTROL:

- A. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.
- B. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.

3.5 CLEANING AND PROTECTING:

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of the issuance of the Certificate of Compliance. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Silicone joint sealants.
2. Preformed joint sealants.
3. Acoustical joint sealants.

B. Related CSI Sections:

1. Division 08 Section 088000, "Glazing" for plastic sealants.
2. Division 09 Section 092900, "Gypsum Board" for sealing perimeter joints.
3. Division 09 Section 093000, "Tiling" for sealing tile joints.

1.2 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.

1.3 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each joint-sealant product indicated.
- C. Quality Assurance Submittals:
 1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.
- D. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- E. Joint-Sealant Schedule: Include the following information:
 1. Joint-sealant application, joint location, and designation.

2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

F. Qualification Data: For qualified Installer and testing agency.

G. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.

H. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.

I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.

1.4 QUALITY ASSURANCE:

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

2. Test according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.

1.5 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. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL:

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Adhesives and Sealants: Adhesives and sealants are certified for low VOCs by the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," include 2004 Addenda or are certified as low VOC by one of the following:
 - 1. Scientific Certification Systems – Indoor Advantage-Gold
 - 2. GREENGUARD Certification Program
 - 3. Green Seal GX-36 (adhesives and sealants)
- C. Colors of Exposed Joint Sealants: As selected by Designer from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS:

- A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use NT.
 - 1. Available Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Dow Corning Corporation; 790.
 - b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
 - c. May National Associates, Inc.; Bondaflex Sil 290.
 - d. Tremco Incorporated; Spectrem 1.
- B. Multicomponent, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT.
 - 1. Available Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Tremco Incorporated; Spectrem 4TS.
- C. Multicomponent, Pourable, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type M, Grade P, Class 100/50, for Use T.

1. Available Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Dow Corning Corporation; FC Parking Structure Sealant.
- b. May National Associates, Inc.; Bondaflex Sil 728 RCS.

D. Mildew-Resistant, Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Use NT.

1. Available Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Pecora Corporation; 898.

2.3 PREFORMED JOINT SEALANTS:

A. Preformed Silicone Joint Sealants: Manufacturer's standard sealant 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.

1. Available Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. Dow Corning Corporation; 123 Silicone Seal.
- b. GE Advanced Materials - Silicones; UltraSpan US1100.
- c. May National Associates, Inc.; Bondaflex Silbridge 300.
- d. Sealex, Inc.; ImmerSeal.

B. Preformed Foam Joint Sealant: Manufacturer's standard preformed, precompressed, open-cell foam sealant manufactured from urethane foam with minimum density of 10 lb/cu. ft. and impregnated with a nondrying, water-repellent agent. Factory produce in precompressed sizes in roll or stick form to fit joint widths indicated; coated on one side with a pressure-sensitive adhesive and covered with protective wrapping.

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. Dayton Superior Specialty Chemicals; Polytite Standard.
- b. EMSEAL Joint Systems, Ltd.; Emseal 25V.
- c. Sandell Manufacturing Co., Inc.; Polyseal.
- d. Schul International, Inc.; Sealtite.
- e. Willseal USA, LLC; Willseal 150.

2.4 ACOUSTICAL JOINT SEALANTS:

- A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Available Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pecora Corporation; AC-20 FTR.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.

2.5 JOINT SEALANT BACKING:

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.6 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: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION:

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Unglazed surfaces of ceramic tile.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS:

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
 - 4. Provide flush joint profile where indicated per Figure 8B in ASTM C 1193.
 - 5. Provide recessed joint configuration of recess depth and at locations indicated per Figure 8C in ASTM C 1193.

- a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- G. 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 (10 mm). Hold edge of sealant bead 1/4 inch (6 mm) 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.
- H. Installation of Preformed Foam Sealants: Install each length of sealant immediately after removing protective wrapping. Do not pull or stretch material. Produce seal continuity at ends, turns, and intersections of joints. For applications at low ambient temperatures, apply heat to sealant in compliance with sealant manufacturer's written instructions.
- I. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

3.4 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 the issuance of the Certificate of Compliance. 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 079200

SECTION 081416 - FLUSH WOOD DOOR AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Solid-core doors with wood-veneer faces.
2. Solid-core doors with wood-veneer faces and glazing.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.2 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of door. Include details of core and edge construction, louvers, and trim for openings. Include factory-finishing specifications.
- C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; and the following:
1. Dimensions and locations of blocking.
 2. Dimensions and locations of mortises and holes for hardware.
 3. Dimensions and locations of cutouts.
 4. Undercuts.
 5. Requirements for veneer matching.
 6. Doors to be factory finished and finish requirements.
 7. Fire-protection ratings for fire-rated doors.
- D. Sample Warranty: For special warranty.
- E. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body and is a certified participant in AWI's Quality Certification Program.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

1.6 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 3. Warranty Period for Solid-Core Interior Doors: 25 years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain flush wood door from single manufacturer.

2.2 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
 - 1. Provide AWI Quality Certification Labels indicating that doors comply with requirements of grades specified.

2. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.
- B. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.
- C. WDMA I.S.1-A Performance Grade: Heavy Duty.
- D. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 2. Temperature-Rise Limit: Where indicated, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
 3. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 4. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 5. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals. Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
- E. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control, based on testing according to UL 1784.
- F. Structural-Composite-Lumber-Core Doors:
1. Structural Composite Lumber: WDMA I.S.10.
 - a. Screw Withdrawal, Face: 700 lbf
 - b. Screw Withdrawal, Edge: 400 lbf
- G. Mineral-Core Doors:
1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
 2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as follows:
 - a. 5-inch top-rail blocking.
 - b. 5-inch bottom-rail blocking, in doors indicated to have protection plates.
 - c. 5-inch midrail blocking, in doors indicated to have armor plates.
 - d. 5-inch midrail blocking, in doors indicated to have exit devices.

3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
 - a. Screw-Holding Capability: 550 lbf per WDMA T.M.-10.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors (All Wood Doors):

1. Grade: Premium, with Grade AA faces.
2. Species: Match existing mahogany door finishes.
3. Cut: Plain sliced (flat sliced).
4. Match between Veneer Leaves: Book match.
5. Assembly of Veneer Leaves on Door Faces: Center-balance match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
8. Blueprint Match: Where indicated, provide doors with faces produced from same flitches as adjacent wood paneling and arranged to provide blueprint match with wood paneling. Comply with requirements in Section 064216 "Flush Wood Paneling."
9. Exposed Vertical and Top Edges: Same species as faces or a compatible species - edge Type A.
10. Core: Either glued wood stave or structural composite lumber.
11. Construction: Five or seven plies. Stiles and rails are bonded to core, then entire unit is abrasive planed before veneering. Faces are bonded to core using a hot press.
12. Construction: Seven plies, either bonded or nonbonded construction.
13. WDMA I.S.1-A Performance Grade: Heavy Duty.
14. For wood doors with glazing provide a minimum of 5-inch nominal width stile; a minimum of 12-inch nominal bottom rail; and a minimum of 5-inch nominal top rail;

2.4 STANDARD HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
- B. Interior Frames: Where scheduled provide HM frames with face Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.
 1. Fabricate frames with mitered or coped corners.
 2. Fabricate frames with "closed and tight" miter seams continuously welded on face, finished smooth with no visible seam unless otherwise indicated.
 3. Frames for Level 3 Steel Doors (up to 48 inches in width): Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
 4. Frames for Wood Doors: Minimum 16 gauge (0.053-inch-1.3-mm-) thick steel sheet.
 5. Frames for Borrowed Lights: Minimum 16 gauge (0.053-inch-1.3-mm-) thick steel sheet.
 6. Manufacturers Basis of Design for conditions indicated on drawings provide frames for drywall applications shown.
 - a. CECO Door Products (C) - BU/DU Series (Drywall).
 - b. Curies Company (CU) - CM Series (Drywall).

c. Fleming F Series

- C. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
- D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
 - 2. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
 - 3. Provide anchors suitable for application encountered and identify in shop drawing submission.
- B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.

2.6 LIGHT FRAMES

- A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.
 - 1. Wood Species: Same species as door faces.
 - 2. Profile: Flush rectangular beads in order to match existing door staining color.
 - 3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
- B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.
 - 1. Wood Species: Same species as door faces.

2.7 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
 - 1. Comply with NFPA 80 requirements for fire-rated doors.
- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.

1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.
1. Fabricate door and transom panels with full-width, solid-lumber, rabbeted, meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.
- D. Openings: Factory cut and trim openings through doors.
1. Light Openings: Trim openings with moldings of material and profile indicated.
 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."
 3. Louvers: Factory install louvers in prepared openings.

2.8 SHOP PRIMING

- A. Doors for Transparent Finish: Shop prime faces and all four edges with stain, other required pretreatments, and first coat of finish. Seal edges of cutouts and mortises with first coat of finish.

2.9 FACTORY FINISHING

- A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors that are indicated to receive transparent finish.
- C. Transparent Finish:
1. Grade: Premium.
 2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 9, UV curable, acrylated epoxy, polyester, or urethane] [System 10, UV curable, water based
 3. Finish: WDMA TR-4 conversion varnish or WDMA TR-6 catalyzed polyurethane.
 4. Staining: As selected by Designer from manufacturer's full range in order to match existing door staining color.
 5. Effect: Open-grain finish, Filled finish or Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores in order to match existing door staining color.
 6. Sheen: Satin in order to match existing door staining color.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
 - 1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
 - 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware".
- B. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.
- C. Hollow-Metal Frames: Install hollow-metal frames for doors, transoms, sidelites, borrowed lites, and other openings, of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
 - 4. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.

5. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, 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.
 - D. Installation Instructions: Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
 1. Install fire-rated doors according to NFPA 80.
 2. Install smoke- and draft-control doors according to NFPA 105.
 - E. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
 1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold unless otherwise indicated.
 - a. Comply with NFPA 80 for fire-rated doors.
 - b. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
 2. Bevel fire-rated doors 1/8 inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.
 - F. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
 - G. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.
- 3.3 ADJUSTING
- A. Operation: Rehang or replace doors that do not swing or operate freely.
 - B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083213 - SLIDING ALUMINUM-FRAMED GLASS DOORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes sliding aluminum-framed glass doors separating the highway operations center and the storm center.
- B. Related Requirements:
 - 1. Section 084113 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units on the building interior.

1.2 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, fabrication methods, dimensions of individual components and profiles, hardware, finishes, and operating instructions.
- C. Shop Drawings: For sliding aluminum-framed glass doors.
 - 1. Include plans, elevations, sections, and details.
 - 2. Detail attachments to other work, and between units, if any.
 - 3. Include hardware and required clearances.
- D. Samples for Initial Selection: For each type of sliding aluminum-framed glass door indicated.
 - 1. Include Samples of hardware and accessories involving color selection.
- E. Samples for Verification: For sliding aluminum-framed glass doors and components required, prepared on Samples of size indicated below:
 - 1. Main Framing Member: 12-inch-long section with weather stripping, glazing bead, and factory-applied color finish.
 - 2. Hardware: Full-size units with factory-applied finish.
 - 3. Door: swing direction and hardware.
- F. Qualification Data: For Installer manufacturer and testing agency.

- G. Product Test Reports: For each sliding aluminum-framed glass door, for tests performed by manufacturer and witnessed by a qualified testing agency, and for each class and performance grade indicated, tested at AAMA gateway size.
- H. Field quality-control reports.
- I. Sample Warranty: For manufacturer's special warranty.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For countertops include maintenance manual to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating sliding aluminum-framed glass doors that meet or exceed performance requirements indicated and of documenting this performance by inclusion in lists and by labels, test reports, and calculations. Manufacturer capable of providing complete, precision built, engineered, pre-fitted units with a minimum twenty-five (25) years' experience in the sale of folding-sliding door systems for large openings in the North American market.
 - 1. Manufacturer to have ISO 9001: 2008 quality management system registration.
 - 2. Manufacturer to have ISO 14001: 2005 environmental management system registration.
 - 3. Furnish Sliding Glass Storefront system materials from one manufacturer for entire Project.
- B. Installer Qualifications: An installer acceptable to sliding aluminum-framed glass door manufacturer for installation of units required for this Project.
 - 1. Installer experienced in the installation of manufacturer's products or other similar products for large openings. Installer to provide reference list of at least three (3) projects of similar scale and complexity successfully completed in the last three (3) years.
 - 2. Installer to be trained and certified by manufacturer
- C. Conduct a Pre-Installation meeting at the Project Site in compliance with the requirements of Form 817 Article 1.20-1.05.24 subsection 2 to discuss the proposed installation.

1.5 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of sliding aluminum-framed glass doors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to meet performance requirements.
 - b. Structural failures including excessive deflection.
 - c. Excessive water leakage or air infiltration.
 - d. Faulty operation of movable panels and hardware.
 - e. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - f. Failure of insulating glass.
 - 2. Warranty Period:
 - a. Sliding Door: 10 years from date of Substantial Completion.
 - 1) Rollers and Glass Seal Failure: Ten (10)
 - b. Insulating-Glass Units: 20 years from date of Substantial Completion.
 - c. Aluminum Finish: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product by Manufacturer: NanaWall HSW60 by NANA WALL SYSTEMS, INC or approved equal.
 - 1. Source Limitations: Obtain sliding aluminum-framed glass doors and all accessories from single source from single manufacturer.
- B. Panel Configuration:
 - 1. Straight (7 individual panels)
 - a. One swinging door panel for egress purposes.
 - b. Sizes and Configurations: As indicated by the drawings for selected number and size of panels, location of swing panels, and location of tracks and stacking bays.
 - 2. Adjustable sliding and swing hardware with top track.
 - 3. Stack Storage Configuration: behind wall as indicated by the drawings.
 - 4. Mounting Type: Top hung
 - 5. Panel Type: Multiple unattached
 - a. With Entry/Egress panel convertible to sliding panel.

2.2 PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 - 1. Product Certification: AAMA certified with label attached to each door.
- B. Sound Transmission Class (STC): Rated for not less than 40 STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.

2.3 SLIDING ALUMINUM-FRAMED GLASS DOORS

- A. Frames and Door Panels: Fabricated from aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.
- B. Swing Door Panel - Operation / Cycling Performance (AAMA 920)
- C. Threshold and Sill Cap/Track: Provide extruded-aluminum threshold and track of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated; with manufacturer's standard finish.
 - 1. Low-Profile Floor Track: ADA-ABA compliant.

2.4 GLAZING SYSTEMS

- A. Glazing: As specified in Division 08 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

2.5 HARDWARE

- A. General: Provide manufacturer's standard hardware, fabricated from a corrosion-resistant material compatible with aluminum complying with AAMA 907 and designed to smoothly operate, tightly close, and securely lock sliding aluminum-framed glass doors.
- B. Door Pulls: Provide manufacturer's standard pull.
 - 1. Color and Finish: As selected by Designer from manufacturer's full range of standard, premium and custom colors.

- C. Lock: Install manufacturer's keyed cylinder lock and multipoint locking device on each movable panel, lockable from the inside and outside. Adjust locking device to allow unobstructed movement of the panel across adjacent panel in the direction indicated.

- 1. Keying System: Keyed to match other building entrances.

2.6 ACCESSORIES

- A. Fasteners: Noncorrosive and compatible with door members, trim, hardware, anchors, and other components.

- 1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

- B. Anchors, Clips, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron for sliding aluminum-framed glass doors, complying with ASTM B 456 or ASTM B 633 for SC 3 severe service conditions; provide sufficient strength to withstand design pressure indicated.

- 1. Windborne-Debris Resistance: Provide anchors of same design used in windborne-debris resistance testing.

2.7 FABRICATION

- A. Fabricate sliding aluminum-framed glass doors in sizes indicated. Include a complete system for assembling components and anchoring doors.

- B. Fabricate sliding aluminum-framed glass doors that are reglazable without dismantling panel framing.

- C. Weather Stripping: Provide full-perimeter weather stripping for each door panel.

- D. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

- E. Factory-Glazed Fabrication: Glaze sliding aluminum-framed glass doors in the factory where practical and possible for applications indicated. Comply with requirements in Section 088000 "Glazing" and with AAMA/WDMA/CSA 101/I.S.2/A440.

2.8 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. 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.

2.9 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: As selected by Designer from the manufacturer's full range of standard, premium, and custom colors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of threshold substrate, and operational clearances.
- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure a coordinated, weathertight sliding aluminum-framed glass door installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing doors, hardware, accessories, and other components.
- B. Windborne Debris Resistance: Anchor sliding aluminum-framed glass doors that have been tested for windborne debris resistance to structure using anchoring method, fastener type, and fastening frequency identical to that used in windborne debris resistance testing.

- C. Install sliding aluminum-framed glass doors level, plumb, square, true to line, without distortion, without warp or rack of frames and panels, and without impeding thermal movement; anchored securely in place to structural support; and in proper relation to wall flashing, vapor retarders, air barriers, water/weather barriers, and other adjacent construction.
- D. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.
- E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Lubricate hardware and moving parts.
- B. Adjust operating panels and screens to provide a tight fit at contact points and weather stripping for smooth operation, without binding, and a weathertight closure. Adjust hardware for proper alignment, smooth operation, and proper latching without unnecessary force or excessive clearance.
- C. Clean exposed surfaces immediately after installing sliding aluminum-framed glass doors. Avoid damaging protective coatings and finishes. Remove nonpermanent labels, excess sealants, glazing materials, dirt, and other substances.
- D. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- E. Protect sliding aluminum-framed glass door surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances contact sliding aluminum-framed glass door surfaces, remove contaminants immediately according to manufacturer's written instructions.
- F. Refinish or replace sliding aluminum-framed glass doors with damaged finishes.
- G. Replace damaged components.

END OF SECTION 083213

SECTION 084113 - ALUMINUM-FRAMED STOREFRONTS AND ENTRANCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior storefront system.
2. Interior manual-swing entrance doors and door frame units.
3. Exterior storefront system.
4. Exterior manual-swing entrance doors and door frame units.

1.2 PERFORMANCE REQUIREMENTS

A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:

1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
2. Dimensional tolerances of building frame and other adjacent construction.
3. Failure includes the following:
 - a. Deflection exceeding specified limits.
 - b. Thermal stresses transferring to building structure.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
 - d. Noise or vibration created by wind and by thermal and structural movements.
 - e. Loosening or weakening of fasteners, attachments, and other components.
 - f. Failure of operating units.

B. Deflection of Framing Members:

1. Deflection Normal to Wall Plane: Limited to $1/175$ of clear span for spans up to 13 feet 6 inches and to $1/240$ of clear span plus $1/4$ inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to $3/8$ inch, whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to $L/360$ of clear span or $1/8$ inch, whichever is smaller.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Submit manufacturer’s product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
- C. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
 - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 - 2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
- D. Samples:
 - 1. Color Selection: Submit color samples to match the existing “Duranotic” finish for selection of color by Designer.
 - 2. Verification Samples: Provide pairs of samples of each type of aluminum type and color on 12-inch long sections of extrusions or formed shapes and on 6-inch squares of aluminum sheet or plate. Include (2) or more units in each sample set showing extreme limits of variations expected in color and texture.
 - a. Aluminum Framing:
 - 1) Corner Section including sample of interior mullion with structural silicone glazed condition: 12 inch by 12 inch indicating corner construction, fasteners, and glazing methods, and proposed anchor system.
 - 2) Finish: 24 inch long typical section.
 - a) Glazing: 12 inch by 12 inch corner piece of gasket.

- b) Each Type of Glass: 12 inches by 12 inches.
- c) Joint Sealer: In accordance with Division 07.

E. Quality Control Submittals

1. Test Reports: Provide Certified Independent Laboratory test reports from window system manufacturer's qualified independent testing laboratory verifying compliance of system with specified requirements based on comprehensive testing of system by laboratory.
2. Certificates: Submit installer certificates signed by manufacturer certifying that Installer complies with specified requirements.
 - a. Submit section model of wind-load-bearing members and calculations of stresses and deflections. Provide material properties and other information needed for structural analysis, including computations, which have been prepared, signed, or sealed by a professional engineer licensed in the jurisdiction where the Project is located.
 - b. Submit structural calculations bearing seal of professional engineer licensed in state where Project is located indicating compliance of glazed aluminum window system with Design Wind Load requirements specified in above.
 - c. Glass Manufacturer's Certificates: Submit manufacturer's written certification that:
 - 1) After review of project glass and glazing design; glass types, glass thicknesses, and glazing details are suitable for intended purposes.
 - 2) After wind load analysis, each piece of exterior glass can withstand design wind loads with failure probability no greater than requirements of Contract Documents.
 - 3) Project glazing details will not void glass fabricator's warranty.
 - d. For each exposed finish.
 - e. Product test reports.
 - f. Field quality-control test reports.
 - g. Certificates: Submit coating manufacturer's written certification that AAMA 2605 Fluoropolymer coating applicator is approved applicator.

1.4 QUALITY ASSURANCE

- A. Manufacturer/Fabricator/Installer Qualifications: Installer to be acceptable, in writing, to manufacturer and capable of preparing data for glazed aluminum window systems including; Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
 1. Single Source: Products to be provided by a single source.

2. **Manufacturers:** Company specializing in aluminum window systems construction with minimum of ten (10) years documented successful experience. Company capable of providing field service representation during construction, approving acceptable installer and approving application method.
 3. **Installer:** Single firm experienced in installation of products specified, certified or approved by manufacturer for installation of materials indicated and meeting warranty requirements. Installer to have a minimum of (5) years of experience in installing commercial scale systems with a minimum of (5) successfully completed installations over the past (3) years. Provide MFR certification in writing for installer.
 4. **Installer Experience Listing:** Submit list of completed projects using products proposed for the Project, including owner's contact and telephone number for each project, demonstrating compliance with applicable "Qualification" requirements specified in "Quality Assurance".
 5. **Welding and Welders:** Skilled and qualified welders, licensed where required in accord with local building regulations. Perform welding in conformance with AWS Structural Welding Code D1.1 and as recommended by manufacturer.
- B. **Fabrication Erection and Finishing Standards:** Applicable standards of AA, AAMA and AWS.
- C. **Contractor's Structural Silicone Glazing Quality Control Program:**
1. Monitor quality of cleaners, primers, silicone sealant, workmanship, and adhesion of structural silicone glazing.
 2. Program: Include initial testing of components for sealant adhesion and compatibility, as well as random testing of production run materials.
 3. Include methods to monitor sealant application to ensure full sealant contact.
 4. Do not perform any sealant work prior to acceptance of quality control program.
- D. **AAMA 2605 Fluoropolymer Coating Applicator Qualifications:** Coating manufacturer approved.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. **General:**
1. Aluminum: Comply with AAMA.
 2. Glass: Comply with Division 08.

3. Delivery: Schedule delivery to coincide with glazing schedules so that minimum handling of crates is required. Do not open crates except as required for inspection for shipping damage. Ensure that identification labels are intact.
4. Storage: Store cases according to printed instruction on case, in areas least subject to traffic or falling objects. Keep storage area clean and dry. Protect window system material against damage from elements, construction activities, and other hazards before, during and after window system installation.
5. Handling: Unpack cases following printed instructions on case. Stack individual doors on edge leaned slightly against upright supports with separators between each.

1.6 PROJECT / SITE CONDITIONS

1. Field Measurements: Take field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

1.7 SEQUENCING AND SCHEDULING

- A. Schedule installation of window system in sequence with related elements of the Work specified in other Sections to ensure wall assemblies, including flashing, trim, and joint sealers, are protected against damage from effects of weather, age, corrosion, and other causes.

1.8 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of glazed aluminum window systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
- C. Warranty: Provide ten (10) year written warranty covering materials and installation for aluminum window system.
 1. Warranty: Signed jointly and severally by aluminum framing, and glass manufacturers, installer, and Contractor, agreeing to repair or replace any work performed under this Section which fails. Warranty shall also include costs associated with repair of any damage caused on interior of building due to leakage of window system
 2. 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 metal finishes, and other materials beyond normal weathering.
 - d. Water leakage.
 - e. Failure of operating components to function normally.
2. Warranty Period: Ten (10) years from date of Substantial Completion.
- D. 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. Finish Warranty Period: (20) years from date of Substantial Completion.
- E. Contractor/Installer Warranty: In addition to manufacturer's warranty described above, submit written warranty signed by authorized representative of Contractor and installer warranting that portions of the Work involving glazed aluminum window system are of good quality, free from defects, and in conformance with requirements of Contract Documents and further agreeing to repair or replace defective work occurring during a ten (10) year period following completion of that portion of the work.
- F. "Defective" is defined to include: glass breakage, failure of operational parts to function normally, deterioration or discoloration of finishes, or failure of system to meet performance requirements.
- G. The Warranty submitted under this Section shall not deprive the Owner of other rights or remedies that the Owner may have under other provisions of the Contract Documents or prevailing local laws; and is in addition to, and runs concurrent with, other warranties made by the Contractor under other requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Interior Storefront System **SF1** (at all interior storefront conditions) Basis-of-Design Product: Subject to compliance with requirements, provide Inframe Interior Framing System, as manufactured by Kawneer North America; an Alcoa Company, or comparable product by one of the following:
 - 1. Arch Aluminum & Glass Co., Inc.
 - 2. EFCO Corporation.
 - 3. Tubelite.
 - 4. United States Aluminum.

5. Vistawall Architectural Products; The Vistawall Group; a Bluescope Steel company.

Plan sheet notes identifying the finish as "Anodized Aluminum" shall be disregarded. The finish shall be "Duranotic."

- B. Exterior Storefront System **SF2** (at existing exterior storefront condition) Basis-of-Design Product: Subject to compliance with requirements, provide TriFab 601T, as manufactured by Kawneer North America; an Alcoa Company, or comparable product by one of the following:
 1. Arch Aluminum & Glass Co., Inc.
 2. EFCO Corporation.
 3. Tubelite.
 4. United States Aluminum.
 5. Vistawall Architectural Products; The Vistawall Group; a Bluescope Steel company.

Plan sheet notes identifying the finish as "Match Existing Storefront" shall mean "Duranotic."

2.2 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 1. Sheet and Plate: ASTM B 209.
 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 3. Extruded Structural Pipe and Tubes: ASTM B 429.
 4. Structural Profiles: ASTM B 308/B 308M.
 5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

2.3 FRAMING SYSTEMS

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Construction: Thermally broken at exterior locations.
 2. Glazing System: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: As indicated.
- B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members as required to receive fastener threads.
 - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.
- D. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.

2.4 GLAZING SYSTEMS

- A. Glazing: As specified in Division 08 Section "Glazing."
- B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.
- C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

2.5 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
 - 1. Interior Doors: Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer 500, as manufactured by Kawneer North America; an Alcoa Company, for installation into provide Inframe Interior Framing System or comparable single source product.
 - 2. Interior Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 - 3. Door Design: Wide stile; 5-inch nominal width.
 - a. Accessible Doors: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
 - 4. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.

- a. Provide non-removable glazing stops on outside of door.
 - B. Entrance Door Hardware: As specified in Division 08 Section "Door Hardware."
- 2.6 FABRICATION
- A. Form or extrude aluminum shapes before finishing.
 - B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
 - C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 - 4. Physical and thermal isolation of glazing from framing members.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 6. Provisions for field replacement of glazing from exterior.
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
 - D. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - E. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - F. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
 - G. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions:

1. Existing Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive window system and opening is level in accordance with manufacturer's acceptable tolerances.

a. Field Measurements: Verify actual measurements/openings by field measurements before fabrication; show recorded measurements on shop drawings. Coordinate field measurements, fabrication schedule with construction progress to avoid construction delays.

B. Verification of conditions: Examine conditions under which glazed window system is to be installed in coordination with installer of materials and components specified in this Section and notify affected Prime Contractors in writing, with copies to the Owner's Representative and Architect, of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

C. When Installer confirms conditions as acceptable to ensure proper and timely installation and to ensure requirements for applicable warranty or guarantee can be satisfied, submit to Prime Contractor written confirmation, with copies to the Owner's Representative and Architect, from applicable Installer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to Installer.

D. General: Comply with manufacturer's instructions for protecting, handling, and installing fabricated window system components, with particular care and attention to preservation of applied finishes. Discard or remove and replace damaged members.

1. Fit joints to produce hairline joints free of burrs and distortion.
2. Rigidly secure non-movement joints.
3. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
4. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
5. Seal joints watertight, unless otherwise indicated.

- E. Metal Protection:
1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
 2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- F. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- G. Install components plumb and true in alignment with established lines and grades.
- H. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- I. Install glazing as specified Division 8 Section "Glazing."
- J. Install neutral cure silicone sealants as specified in DIVISION 07 Section "Joint Sealants."
- K. Install insulation materials as specified in DIVISION 07 Section "Thermal Insulation."
- L. Install perimeter fire-containment systems (safing insulation) as specified in Division 07 Section "Penetration FireStopping."
- M. Erection Tolerances: Install glazed aluminum window systems to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 2. Level: 1/8 inch in 12 feet; 1/4 inch in 40 feet.
 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or greater, limit offset from true alignment to 1/4 inch.

4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Provide manufacturer's field service consisting of product use recommendations and periodic site visits, one at beginning, one at middle, and one at end of construction, for inspection of product installation in accordance with manufacturer's instructions.

3.3 ADJUSTING/CLEANING

- A. Clean completed system, inside and out, promptly after erection and installation of glass and sealants, allowing for nominal curing of liquid sealants. Installer shall advise Contractor of proper and adequate procedures for protection and cleaning during remainder of construction period so that system will be without damage and deterioration at time of acceptance.
- B. Repair or replace damaged installed products.
- C. Exercise care to avoid damage to finish, wall members, fastenings, and protective coating (if any).
- D. Protection: Protect installed products finish surfaces from damage during construction. Protect aluminum window system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.
- E. At Substantial Completion, clean window system thoroughly and polish glass.

END OF SECTION

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:
 - a. Swinging doors.
2. Electrified door hardware.

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames" for astragals provided as part of labeled fire-rated assemblies.
2. Section 081416 "Flush Wood Doors" for astragals and integral intumescent seals provided as part of labeled fire-rated assemblies.

1.2 COORDINATION

- A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Security: Coordinate installation of door hardware and access control with Engineer's security consultant.
- C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- D. ConnDOT has a Statewide System of Master Ring Locks using Corbin-Russwin jumbo-sized housings and Medeco LFIC cylinders.

1.3 PREINSTALLATION MEETINGS

- A. Conduct Pre-installation Meeting at the project site in compliance with requirements of Form 817 Article 1.20-1.05.24 subsection 2.
 1. Meeting participants shall include Installer's Architectural Hardware Consultant (ACSC), Installer, Owner and their security consultant, and the Engineer.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR-SUBMITTALS.
- B. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Shop Drawings: For electrified door hardware.
 - 1. Include diagrams for power, signal, and control wiring.
 - 2. Include details of interface of electrified door hardware and building safety and security systems.
- D. Samples for Initial Selection: For each exposed product in each finish specified, in manufacturer's standard size.
 - 1. Tag Samples with full product description to coordinate Samples with door hardware schedule.
- E. Samples for Verification: For each type of exposed product, in each finish specified.
 - 1. Sample Size: Full-size units or minimum 2-by-4-inch Samples for sheet and 4-inch long Samples for other products.
- F. Door Hardware Schedule: Prepared by or under the supervision of Installer's ACSC. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 - 1. Submittal Sequence: Submit door hardware schedule after submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
 - 2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract.
 - 3. Content: Include the following information:
 - a. Identification number, location, hand, fire rating, size, and material of each door and frame.
 - b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
 - c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
 - d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
 - e. Fastenings and other installation information.

- f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
- g. Mounting locations for door hardware.
- h. List of related door devices specified in other Sections for each door and frame.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and Architectural Hardware Consultant-Architectural Hardware consultant shall possess Door Hardware Institute ACSC certification.
- B. Product Certificates: For each type of electrified door hardware.
 - 1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.
- C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware include maintenance manual to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.
- B. Schedules: Final door hardware.

1.7 SPARE PARTS:

- A. Furnish to the Engineer spare parts that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Door Hardware: Provide 1 of each lockset and closer unit specified.
 - 2. Electrical Parts: Provide 1 of each electric strike, card reader and power supply unit specified.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an ACSC Certified Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Designer, and Engineer about door hardware.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware.
 - 3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
- B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an DHSC Door and Hardware Specification Consultant.
- C. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws.
 - 1. Furnish screws for installation with each hardware item. Provide Phillips flat head screws except as otherwise indicated. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible, including "prepared for paint" surfaces to receive painted finish.
 - 2. Provide sex bolts for all door closer installations on the doors. All door closer arms to use machine screws. No self-tapping fasteners are allowed on any hardware.

1.9 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 coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

1.10 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.

- B. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of doors and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:
 - a. Electric Strikes, Power supplies: Five years from date of Substantial Completion.
 - b. Exit Devices: Two years from date of Substantial Completion.
 - c. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of door hardware from single manufacturer.
 - 1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
- B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
 - 1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.
- C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- D. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.
- E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the DOJ's "ADA Standards for Accessible Design (ADAAG)" and ICC A117.1
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
 - 2. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
 - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
 - 3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
 - 4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.

2.3 SCHEDULED DOOR HARDWARE

- A. Provide products for each door that comply with requirements indicated in Part 2 and door hardware schedule.
 - 1. Door hardware is scheduled in Part 3.

2.4 HINGES

- A. MANUFACTURERS
 - a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) Hagar
 - 2) IVES an Allegion Brand
 - 3) Stanley Security Solutions
- B. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.
- C. Antifriction-Bearing Hinges:
 - 1. Mounting: Full mortise (butts)
 - 2. Bearing Material: Ball bearing.
 - 3. Grade 1 (heavy weight).
 - 4. Base and Pin Metal:

- a. Interior Hinges: Brass with stainless-steel pin body and brass protruding heads.
 - b. Hinges for Fire-Rated Assemblies: Steel with steel pin.
- 5. Pins: Nonremovable.
- 6. Tips: Flat button.
- 7. Corners: Square.
- D. Plain-Bearing Hinges: Grade 3 (standard weight).
 - 1. Mounting: Full mortise (butts).
 - 2. Base and Pin Metal: Brass with stainless-steel pin body and brass protruding heads.
 - 3. Pins: Nonremovable.
 - 4. Tips: Flat button.
 - 5. Corners: Square.

2.5 MECHANICAL LOCKS AND LATCHES

A. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) Corbin Russwin an ASSA ABLOY Brand

B. Lock Functions: As indicated in door hardware schedule.

C. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

- 1. Mortise Locks: Minimum 3/4-inch latchbolt throw.
- 2. Deadbolts: Minimum 1-inch bolt throw.

D. Lock Backset: 2-3/4 inches unless otherwise indicated.

E. Lock Trim:

- 1. Description: Basis-of-Design: Corbin Russwin; ML2000 Series; NSR, Newport Lever.
 - a. Construction: Solid
- 2. Escutcheons (Roses): Forged.
- 3. Dummy Trim: Match lever lock trim and escutcheons.

F. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
3. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

2.6 PUSH BUTTON LOCKS

A. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by the following or an approved equal:
 - 1) KABA Simplex
- b. BHMA Grade 1, heavy-duty lock:
 - 1) No battery operation
 - 2) Finish: 606
 - 3) LFIC Core compatible
 - 4) Clutch-free direct-drive design.

2.7 ELECTRIC STRIKES

A. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) Alarm Controls; an ASSA ABLOY Brand
 - 2) HES (Folger Adam), an ASSA ABLOY Brand
 - 3) Von Duprin, an Allegion Brand

B. Electric Strikes: BHMA A156.31; Grade 1; with faceplate to suit lock and frame.

1. Material: Stainless Steel.
2. Mounting: Mortised.
3. All Door Assemblies: Use fail-secure electric strikes.
4. Provide all rectifiers, adapters and bridges as required for a complete assembly.

2.8 MANUAL FLUSH BOLTS

A. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) IVES
 - 2) Rockwood Manufacturing; an ASSA ABLOY Brand

3) Don-Jo

- B. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.
- C. Manual-Extension Flush Bolts: Grade 1, fabricated from extruded brass or aluminum, with 12-inch rod actuated by flat lever.
 - 1. Strike: Dustproof.
 - 2. Fire Rated: Listed and labeled for use in fire-rated assemblies.
- D. Dustproof Strikes: Locking type, Grade 1, polished wrought brass, with 3/4-inch-diameter, spring-tension plunger.

2.9 EXIT DEVICES AND AUXILIARY ITEMS

A. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) Von Duprin an Allegion Brand

- B. Exit Devices and Auxiliary Items: BHMA A156.3.
- C. 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.
- D. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
- E. Rim Exit Devices: Grade 1.
 - 1. Type: 1, rim.
 - 2. Actuating Bar: Push pad.
 - 3. Material: Aluminum.
- F. Exit Device Outside Trim: Lever with cylinder material and finish to match locksets unless otherwise indicated.
 - 1. Von Duprin 606.

2.10 LOCK CYLINDERS

- A. Lock Cylinders: Medeco, No substitution. BHMA A156.5; U.L. Listed, Level A permanent cores; face finished to match lockset.

1. Core Type: LFIC.
 2. Number of Pins: Six.
 3. G3 biaxial keyway
 4. Lock Type: Mortise and Rim type.
 5. Finish: 606.
- B. Lock Cylinder Housing: Lock Cylinder Housing Medeco 32 series rim or mortise as required.
- C. Construction and Permanent Cores: The Contractor shall provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys. Cores shall be 6 pin.
1. Provide final unkeyed permanent Medeco cores for each keyed lockset, rim device and removable mullion.
 2. Deliver to:

Mr. David A. Hartley
Connecticut Department of Transportation
2800 Berlin Turnpike
Newington, CT 06111

2.11 KEYING

- A. Keys: Nickel silver.

2.12 SURFACE CLOSERS

- A. All Surface Closers shall comply with the following:
1. Surface Closer shall be a premium graded handed and individual sized door closer. Universal non-handed and sized closers shall not be used. Closers having dual spindles for both left and right hands shall not be used.
 2. Closer shall be fully hydraulic, full rack and pinion construction, having a high strength cast iron cylinder.
 3. Door Closer shall have separate valves for backcheck, closing speed and latching speed.
- B. Surface Closers: Manufacturer, subject to compliance with requirements, provide products by the following: LCN 4040XP Closers. BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions 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.
- C. Surface Closer with Cover: Grade 1; Modern type with mechanism enclosed in cover.

1. Mounting: Parallel arm.
2. Type: Regular arm
3. Backcheck: Factory preset, effective between 60 and 85 degrees of door opening.
4. Cover Material: Metal with a 606 finish.
5. Closing Power Adjustment: At least 35 percent more than minimum tested value.

2.13 MECHANICAL STOPS AND HOLDERS

A. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) IVES
 - 2) Rockwood Manufacturing; an ASSA ABLOY Brand
 - 3) Glynn Johnson

B. Wall- and Floor-Mounted Stops: BHMA A156.16.

C. Rigid-Type Floor Stop: Grade 1; with rubber bumper.

1. Provide with extruded-aluminum riser for carpet installations.

D. Wall Bumpers: Grade 1; with rubber bumper; 2-1/2-inch diameter, minimum 3/4-inch projection from wall; with backplate for concealed fastener installation.

1. Bumper Configuration: Concave.

2.14 OVERHEAD STOPS AND HOLDERS

A. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) Glynn-Johnson; an Allegion Brand
 - 2) Hagar
 - 3) LCN

B. Overhead Stops and Holders: BHMA A156.8.

C. Overhead Surface-Mounted, Friction Slide Holders: Type 5; Grade 1; with frictional element held under adjustable pressure, free-acting shoulder pivots, and shock absorber; for single-acting doors opening 110 degrees.

2.15 DOOR GASKETING

A. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) National Guard Products
 - 2) Zero International
 - 3) Pemko Manufacturing; an ASSA ABLOY Brand

- B. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

- C. Maximum Air Leakage: When tested according to ASTM E 283 with tested pressure differential of 0.3-inch wg (75 Pa), as follows:
 - 1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. of door opening.
 - 2. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
 - 3. Gasketing on Double Doors: 0.50 cfm per foot of door opening.

- D. Rigid, Housed, Perimeter Gasketing: Silicone bulb gasket material held in place by housing; fastened to frame stop with screws.
 - 1. Housing Material: Aluminum

- E. Adjustable Astragals for Meeting Stiles: Screw-adjustable, silicone gasket material held in place by housing; mounted with screws.
 - 1. Housing Material: Aluminum.
 - 2. Mounting: Mortised into edge of each door.

- F. Automatic Door Bottoms: Silicone gasket material held in place by housing that automatically drops to form seal when door is closed; mounted to bottom edge of door with screws.
 - 1. Housing Material: Aluminum
 - 2. Mounting: Mortised into bottom of door.
 - 3. Type: Low-closing-force type for doors required to meet accessibility requirements.

2.16 THRESHOLDS

A. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) National Guard Products
 - 2) Zero International
 - 3) Hagar

- B. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

- C. Saddle Thresholds:
 - 1. Type: Smooth top; barrier free.
 - 2. Base Metal: Aluminum.

2.17 METAL PROTECTIVE TRIM UNITS

A. MANUFACTURERS

- a. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1) IVES
 - 2) Rockwood Manufacturing; an ASSA ABLOY Brand
 - 3) Hagar

B. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- thick aluminum; with manufacturer's standard machine or self-tapping screw fasteners.

C. Kick Plates: 10 inches high by door width with allowance for frame stops.

2.18 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

B. Silencers for Wood Door Frames: Grade 1; neoprene or rubber; minimum 5/8 by 3/4 inch; fabricated for drilled-in application to frame.

C. Silencers for Metal Door Frames: Grade 1; neoprene or rubber; minimum diameter 1/2 inch; fabricated for drilled-in application to frame.

2.19 AUXILIARY ELECTRIFIED DOOR HARDWARE

A. Boxed Power Supplies: Modular unit in NEMA ICS 6, Type 4 enclosure; filtered and regulated; voltage rating and type matching requirements of door hardware served; listed and labeled for use with fire-alarm systems.

2.20 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.

- 1. Manufacturer's identification is permitted on rim of lock cylinders only.

- B. Base Metals: Produce door hardware units of base metal indicated, 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.
- C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. 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. Fire-Rated Applications:
 - a. Wood or Machine Screws: For the following:
 - 1) Hinges mortised to doors or frames; use threaded-to-the-head wood screws for wood doors and frames.
 - 2) Strike plates to frames.
 - b. Steel Through Bolts: For the following:
 - 1) Closers to doors and frames.
 - 2) Surface-mounted exit devices.
 - 3. Spacers or Sex Bolts: For through bolting of hollow-metal doors or wood doors.
 - 4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.21 FINISHES

- A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.
- 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.
- B. Wood Doors: Comply with door and hardware manufacturers' written instructions.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Wood Doors: DHI's "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. 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. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

- D. Lock Cylinders: Install construction cores to secure building and areas during construction period.
- E. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room. Verify location with Architect.
 - 1. Configuration: Provide one power supply for each door opening with electrified door hardware.
- F. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."
- G. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.
- H. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 1. Do not notch perimeter Gasketing to install other surface-applied hardware.
- I. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- J. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

- A. Independent Architectural Hardware Consultant: 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 to comply with accessibility requirements and requirements of authorities having jurisdiction.
 - 2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

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 that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Engineer's continued adjustment, maintenance, and removal and replacement of door hardware.

3.8 DEMONSTRATION

- A. Refer to Form 817 Article 1.20-1.08.14 subsection 3 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Train Engineer's maintenance personnel to adjust, operate, and maintain door hardware.

3.9 DOOR HARDWARE SCHEDULE

DOOR HARDWARE SETS

Manufacturers Abbreviations

KABA: KABA
AC: Alarm Controls; ASSA ABLOY
MED: Medico; ASSA ABLOY
VON: Von Duprin; Allegion
COR: Corbin Russwin; ASSA ABLOY
HAGAR: Hagar
LCN: LCN
HES: Folger Adam; ASSA ABLOY
Best: Best Locks
NGP: National Guard Products
GLYN: Glynn-Johnson
IVES: IVES

Door Hardware Set No. 1, Interior Office Door

Door No. 110, 111, 120, 126 each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1279	606
1	Lockset	COR ML2055	606
1	Core-Permanent	MED LFIC	606
1	Core Housing	MED 32 Series	606
1	Core-Temporary		606
1	Set Silencers		Gray

Door Hardware Set No. 1A, Interior Office Door (IT Engineering Office)

Door No. 112 each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1279	606
1	Lockset	COR ML2055	606
1	Core-Permanent	MED LFIC	606
1	Core Housing	MED 32 Series	606
1	Core-Temporary		606
1	Wall Bumper	IVES WS406 CCV	606
1	Set Silencers		Gray

Door Hardware Set No. 2, Interior Pair of Doors (Closets)

Door No 116, 122B, 123B, 149 each pair of doors to have the following

No.	Item	Description	Finish
6	Hinge	HAGAR BB1279	606
1	Lockset	ML2057	606
1	Core-Permanent	MED LFIC	606
1	Core Housing	MED 32 Series	606
1	Core-Temporary		606
2	Stop	GLYN 410F	606
2	Flush Bolt	IVES FB358	606
1	Dustproof Strike	IVES DP-1	606
2	Set Silencers		Gray

Door Hardware Set No. 2A, Interior Office Door (Ops Storage)

Door No. 311, 312 each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1191	606
1	Lockset	COR ML2055	606
1	Core-Permanent	MED LFIC	606
1	Core Housing	MED 32 Series	606
1	Core-Temporary		606

1	Closer @ 312	LCN 4040XP-3049EDA MC SNB	606
1	Wall Bumper-@ 311	IVES WS406 CCV	606
1	Stop-@ 312	GLYN 410F	606
1	Set Silencers		Gray

Door Hardware Set No. 2B, Interior Office Door (Comms. Closet)
Door No. 318 each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1191	606
1	Lockset	COR ML2055	606
1	Core-Permanent	MED LFIC	606
1	Core Housing	MED 32 Series	606
1	Core-Temporary		606
1	Closer	LCN 4040XP-3049EDA MC SNB	606
1	Wall Bumper	IVES WS406 CCV	606
1	Set Silencers		Gray

Door Hardware Set No. 2C, Interior Office Door, IT OIS Office G130
Door No. 130, 131B each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1279	606
1	Lockset	COR ML2055	606
1	Core Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core- Temporary		606
1	Closer	LCN 4040XP-3049EDA MC SNB	606
1	Wall Bumper	IVES WS406 CCV	606
1	Kickplate	IVES K1050	606
1	Set Silencers		Gray

Door Hardware Set No. 3, Interior Door, Highway Ops Center
Door No. 300A, 300B each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1191	606
1	Latchset	COR ML2010	606
1	Closer	LCN 4040XP-3049EDA MC SNB	606
1	Wall Bumper	IVES WS406 CCV	606
1	Kickplate	IVES K1050	606
1	Set Silencers		Gray

Door Hardware Set No. 4, Interior Office Door, Exam
Door No. 128, 129 each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1279	606
1	Latchset	COR ML2010	606
1	Core Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core-Temporary		606
1	Wall Bumper	IVES WS406 CCV	606
1	Set Silencers		Gray

Door Hardware Set No. 4A, Interior Office Door, Nurse

Door No. 124 each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1279	606
1	Lockset	COR ML2055	606
1	Core-Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core-Temporary		606
1	Wall Bumper	IVES WS406 CCV	606
1	Set Silencers		Gray

Door Hardware Set No. 4B, Interior Office Door; Nurse Exam with Reader; Electric Strike

Door No. 127 each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1191	606
1	Lockset	COR ML2057	606
1	Core-Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core-Temporary		606
1	Wall Bumper	IVES WS406 CCV	606
1	Closer	LCN 4040XP-3049EDA MC SNB	606
1	Reader	By Security Vendor	NA
1	Electric Strike	HES 4500C	NA
1	Power Supply	VON PS914	NA
1	Set Silencers		Gray

Door Hardware Set No. 5, Interior Toilet Door

Door No 125, 310 each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1191	606
1	Latchset	COR ML2060	606
1	Set Silencers		Gray

Door Hardware Set No. 6, Interior Doors; VDTR G303 with Reader; Electric Strike
 Door No. 303A each pair of doors to have the following:

No.	Item	Description	Finish
6	Hinge	HAGAR BB1191	606
1	Rim Exit Device	VON 98-L-06-F-4'-US4	606
1	Rim Exit Device	VON 98-EO-F-4'-US4	606
2	Core-Permanent	MED LFIC	606
2	Core- Housing	MED 32 Series	606
2	Core-Temporary		606
1	Keyed Removable Mullion	VON KR4854	Paint
2	Floor Stop	IVES FS439	606
2	Closer	LCN 4040XP-3049EDA MC SNB	606
2	Kickplate	IVES K1050	606
1	Reader	By Security Vendor	NA
1	Power Supply	VON PS914	NA
1	Electric Strike	HES 7501	630
1	Threshold	NGP 223SA-36	AL
2	FM 200 Bottom seal		Black
	FM 200 Perimeter seal	NGP 700 SA	Black
	FM 200 Meeting seal	NGP 143SA	Black

Door Hardware Set No. 6A, Interior Door; FM 200 Room
 Door No. 319 each pair of doors to have the following:

No.	Item	Description	Finish
6	Hinge	HAGAR BB1191	606
1	Lockset	ML2055	606
1	Core-Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core-Temporary		606
2	Flush Bolt	IVES FB358	606
1	Dustproof Strike	IVES DP-1	606
2	Floor Stop	IVES FS439	606
2	Closer	LCN 4040XP-3049EDA MC SNB	606
1	Threshold		AL
2	FM 200 Bottom seal	NGP 223SA-36	Black
	FM 200 Perimeter seal	NGP 700 SA	Black
	FM 200 Meeting seal	NGP 143SA	Black

Door Hardware Set No. 6B, Interior Door; VDTR with Reader; Electric Strike
 Door No. 303B each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1191	606
1	Rim Exit Device	VON 98-06-F-4'-US4	606

1	Core-Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core-Temporary		
1	Floor Stop	IVES FS439	606
1	Closer	LCN 4040XP-3049EDA MC SNB	606
1	Kickplate	IVES K1050	606
1	Reader	By Security Vendor	NA
1	Electric Strike	HES 7501	NA
1	Power Supply	VON PS914	NA
1	Threshold		AL
1	FM 200 Bottom seal	NGP 223SA-36	Black
1	FM 200 Perimeter seal	NGP 700 SA	Black

Door Hardware Set No. 7, Interior Office Door, TIM Room
Door No. 114A, 114B each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1191	606
1	Rim Exit Device	VON 98-L-06-F-4'-US4	606
1	Core-Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core-Temporary		
1	Wall Bumper	IVES WS406 CCV	606
1	Closer	LCN 4040XP-3049EDA MC SNB	606
1	Set Silencers		Gray

Door Hardware Set No. 8, Interior Door, Conference
Door No. 117, 118, 302 each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1279	606
1	Lockset	COR ML2055	606
1	Core-Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core-Temporary		606
1	Wall Bumper	IVES WS406 CCV	606
1	Set Silencers		Gray

Door Hardware Set No. 9, Interior Office Door, Kitchen
Door No. 306, 307, 309 each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1279	606
1	Lockset	COR ML2055	606
1	Core-Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606

1	Core-Temporary		
1	Wall Bumper	IVES WS406 CCV	606
1	Set Silencers		Gray

Door Hardware Set No. 9A, Interior Door, Storm Center
Door No. 301A each door to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1279	606
1	Lockset	COR ML2055	606
1	Core-Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core-Temporary		
1	Wall Bumper	IVES WS406 CCV	606
1	Set Silencers		Gray

Door Hardware Set No. 10, Interior Doors; Highway Operations Center with Reader; Electric Strike
Door No. 315 each pair of doors to have the following:

No.	Item	Description	Finish
6	Hinge	HAGAR BB1191	606
1	Rim Exit Device	VON 98-F-4'-US4 (use lockset below)	606
1	Pushbutton Lockset	KABA Simplex 5010	606
1	Rim Exit Device	VON 98-EO-4'-US4	606
2	Core-Permanent	MED LFIC	606
2	Core- Housing	MED 32 Series	606
2	Core-Temporary		606
1	Keyed Removable Mullion	VON KR4854	Paint
2	Floor Stop	IVES FS439	606
2	Closer	LCN 4040XP-3049EDA MC SNB	606
2	Kickplate	IVES K1050	606
1	Electric Strike	HES 7501	606
1	Reader	By Security Vendor	NA
1	Power Supply	VON PS914	NA

Door Hardware Set No. 11, Interior Doors; Engineering G305 with Reader; Electric Strike
Door No. 305A each pair of doors to have the following:

No.	Item	Description	Finish
6	Hinge	HAGAR BB1191	606
1	Rim Exit Device	VON 98-L-DT-06-F-4'-US4	606
1	Rim Exit Device	VON 98-EO-4'-US4	606
2	Core-Permanent	MED LFIC	606
2	Core- Housing	MED 32 Series	606
2	Core-Temporary		606

1	Electric Strike	HES 7501	630
1	Power Supply	VON PS914	NA
1	Reader	By Security Vendor	NA
1	Keyed Removable Mullion	VON KR4854	Paint
2	Wall Bumper	IVES WS406 CCV	606
2	Closer	LCN 4040XP-3049EDA MC SNB	606
2	Kickplate	IVES K1050	606

Door Hardware Set No. 12, Interior Door; IT OIS with Reader; Electric Strike
Door No. 131A each pair of doors to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1191	606
1	Lockset	COR ML2057	606
1	Core-Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core-Temporary		606
1	Floor Stop	IVES FS439	606
1	Closer	LCN 4040XP-3049EDA MC SNB	606
1	Kickplate	IVES K1050	606
1	Reader	By Security Vendor	NA
1	Electric Strike	HES 4500C	NA
1	Power Supply	VON PS914	NA

Door Hardware Set No. 13, Interior Door; Library with Reader; Electric Strike
Door No. E304 each pair of doors to have the following:

No.	Item	Description	Finish
3	Hinge	HAGAR BB1191	606
1	Lockset	COR ML2057	606
1	Core-Permanent	MED LFIC	606
1	Core- Housing	MED 32 Series	606
1	Core-Temporary		
1	Floor Stop	IVES FS439	606
1	Closer	LCN 4040XP-3049EDA MC SNB	606
1	Kickplate	IVES K1050	606
1	Reader	By Security Vendor	NA
1	Electric Strike	HES 4500C	NA
1	Power Supply	VON PS914	NA

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Windows.
 - 2. Doors.
 - 3. Interior Storefront
 - 4. Exterior Storefront

1.2 DEFINITIONS

- A. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.
- B. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.
- C. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
- D. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading (where applicable), without failure including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; and other defects in construction.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
- C. General: Submit the following according to Conditions of Contract and Division 01 Specification Sections.
- D. Product data for each glass product and glazing material indicated.
- E. Samples for selection purposes of 12-inch square samples of each type of glass indicated except for clear monolithic glass products, and 12-inch long samples of each color required (except black) for each type of sealant or gasket exposed to view. Install sealant or gasket sample between two strips of material representative in color of the adjoining framing system.
- F. Provide sample of IGU-1 with 10%, 20% and 30% frosted for final selection.
- G. Quality Assurance Submittals:
 - 1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 QUALITY ASSURANCE

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, except where more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. FGMA Publications: "FGMA Glazing Manual."
 - 2. AAMA Publications: AAMA TIR-A7 "Sloped Glazing Guidelines" and "Glass Design for Sloped Glazing."
 - 3. LSGA Publications: "LSGA Design Guide."
 - 4. SIGMA Publications: TM-3000 "Vertical Glazing Guidelines" and TB-3001 "Sloped Glazing Guidelines."
- B. Safety Glass: Products complying with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.

1. Subject to compliance with requirements, provide safety glass permanently marked with certification label of Safety Glazing Certification Council (SGCC) or other certification agency acceptable to authorities having jurisdiction.
- C. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.
- D. Glazing for Fire-Rated Window Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 257.
- E. Insulating Glass Certification Program: Provide insulating glass units permanently marked either on spacers or at least one component lite of units with appropriate certification label of inspecting and testing agency indicated below:
1. Insulating Glass Certification Council (IGCC).
- F. Glazier Qualifications: Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for Project with a record of successful in-service performance.
- G. Single-Source Responsibility for Glass: Obtain glass from one source for each product indicated below:
1. Primary glass of each (ASTM C 1036) type and class indicated.
- H. Single-Source Responsibility for Glazing Accessories: Obtain glazing accessories from one source for each product and installation method indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials to comply with manufacturer's directions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
1. Where insulating glass units will be exposed to substantial altitude changes, comply with insulating glass fabricator's recommendations for venting and sealing to avoid hermetic seal ruptures.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing materials manufacturer or when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Install liquid sealants at ambient and substrate temperatures above 40 deg F (4 deg C).

1.8 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form, made out to Owner and signed by laminated-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in "Definitions", f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 1. Warranty Period: Five years from date of Substantial Completion.
- C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions", f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other portions of Part 2 where titles below introduce lists, the following requirements apply to 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 following:
 - a. AGC Glass Company.
 - b. Pilkington Building Products North America.
 - c. PPG Industries, Inc.

2.2 GLASS PRODUCTS

- A. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- B. Heat-Treated Float Glass (HTFG): ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
 2. Provide Kind HS (heat-strengthened) float glass to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements".
 3. For uncoated glass, comply with requirements for Condition A.
 4. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
 5. Provide Kind FT (fully tempered) float glass in place of Kind HS (heat-strengthened) float glass where safety glass is indicated.
- C. Laminated Glass (LG): ASTM C 1172, and complying with other requirements specified and with the following:
1. Interlayer: Polyvinyl butyral of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
- D. Insulating-Glass Units (IGU), General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified herein and in Part 2 "Insulating-Glass Unit".
1. Provide Kind HS (heat-strengthened) float glass to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements".
 2. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
 3. Sealing System: Dual seal.
 4. Spacer Specifications: Manufacturer's standard spacer material and construction.

2.3 FIRE-RATED GLAZING PRODUCTS

- A. Fire-Protection Rating: As indicated for the assembly in which glazing material is installed, and permanently labeled by a testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Film-Faced Ceramic Glazing Material: Proprietary Category II safety glazing product in the form of a 3/16-inch thick, ceramic glazing material polished on both surfaces, faced on one surface with a clear glazing film, and as follows:
 1. Available Products: "Premium FireLite" (polished on both surfaces) by Nippon Electric Glass Co., Ltd., and distributed by Technical Glass Products, or an approved equal.

2.4 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of material indicated below, complying with standards referenced with name of elastomer indicated below, and of profile and hardness required to maintain watertight seal:
1. Neoprene, ASTM C 864.
 2. EPDM, ASTM C 864.
 3. Silicone, ASTM C 1115.
 4. Thermoplastic polyolefin rubber, ASTM C 1115.
 5. Any material indicated above.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned gaskets of material indicated below; complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal:
1. Neoprene.
 2. EPDM.
 3. Silicone.
 4. Thermoplastic polyolefin rubber.
 5. Any material indicated above.

2.5 GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 4. Colors of Exposed Glazing Sealants: As selected by Designer from manufacturer's full range.
- B. Elastomeric Glazing 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.
1. Single-Component Neutral- and Basic-Curing Silicone Glazing Sealants GS- $\langle\#\rangle$:

- a. Available Products:
 - 1) GE Silicons; SilPruf SCS 2000.
 - 2) Pecora Corporation; 864.
 - 3) Pecora Corporation; 890.
 - 4) Polymeric Systems Inc; PSI-641.
 - 5) Tremco; Spectrem 3.
 - b. Type and Grade: S (single component) and NS (nonsag).
 - c. Class: 50.
 - d. Use Related to Exposure: NT (nontraffic).
 - e. Uses Related to Glazing Substrates: M, G, A, and, as applicable to glazing substrates indicated, O.
- C. Glazing Sealants for Fire-Resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

2.6 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 - 1. AAMA 804.3 tape, where indicated.
 - 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 - 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:
 - 1. Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Identical to product used in test assembly to obtain fire-resistance rating.

2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

2.9 LAMINATED-GLASS UNITS

- A. Heat-Treated Laminated-Glass Units **LG-1** (at all interior door, window and interior storefront locations unless noted otherwise):
 1. Available Manufacturers:
 - a. Old Castle Glass
 - b. Saflex.
 - c. Viracon.
 2. Kind LT, consisting of two lites of fully tempered float glass.
 3. Outer Lite: Class 1 (clear) float glass.
 - a. Kind FT (fully tempered safety glass).
 - b. Thickness: 1/8-inch.
 4. Inner Lite: Class 1 (clear) float glass.
 - a. Kind FT (fully tempered safety glass).
 - b. Thickness: 1/8-inch.
 5. Plastic Interlayer:
 - a. Thickness: 0.030 inch, but not less than that required to comply as a Type II safety glass material.
 - b. Interlayer Color: Clear.

2.10 INSULATING-GLASS UNITS

A. Solar-Control Low-E Insulating-Glass Unit **IGU-1** (at interior windows and movable wall system):

1. Available Manufacturers:
 - a. Viracon – Solarscreen Low E
 - b. PPG Industries – Sun Gate 500
 - c. Guardian – SunGard Series
2. Overall Unit Thickness and Thickness of Each Lite: 1-inch and 1/4-inch.
3. Interspace Content: Air.
4. Outdoor Lite: Class 1 (clear) float glass.
 - a. Kind FT (fully tempered).
5. Indoor Lite: Class 1 (clear) float glass.
 - a. Kind FT (fully tempered).
6. Film: (Provide at movable wall system only, minus door within movable wall system) 20% Frosted portion of glazing on second surface within the interspace. Sample of 10%, 20% and 30% frosted to be provided for final selection.
7. Visible Light Transmittance: 65 percent minimum.
8. Winter Nighttime U-Factor: 0.27 maximum.
9. Summer Daytime U-Factor: 0.24 maximum.
10. Solar Heat Gain Coefficient: 0.38 maximum.
11. Outdoor Visible Reflectance: 10 percent maximum

B. Solar-Control Low-E Insulating-Glass Unit **IGU-2** (glazing to match existing glazing at exterior storefront):

1. Available Manufacturers:
 - a. Viracon – Solarscreen Low E
 - b. PPG Industries – Sun Gate 500
 - c. Guardian – SunGard Series
2. Overall Unit Thickness and Thickness of Each Lite: 1-inch and 1/4-inch.
3. Interspace Content: Argon.
4. Outdoor Lite: Class 2 (tinted) float glass.
 - a. Tint Color: Match existing glazing at exterior storefront.
 - b. Kind LG-1

5. Indoor Lite: Class 1 (clear) float glass.
 - a. Kind FT (fully tempered safety glass).
6. Low-E Coating or Film: Pyrolytic on fourth surface or low-e-coated film suspended in the interspace.
7. Visible Light Transmittance: 65 percent minimum.
8. Winter Nighttime U-Factor: 0.27 maximum.
9. Summer Daytime U-Factor: 0.24 maximum.
10. Solar Heat Gain Coefficient: 0.38 maximum.
11. Outdoor Visible Reflectance: 10 percent maximum

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which glass and glazing products are to be installed in coordination with Installer of materials and components specified in this Section and notify Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Examine glass framing, with glazier present, for compliance with the following:
 1. Manufacturing and installation tolerances, including those for size, squareness, offsets at corners.
 2. Presence and functioning of weep system.
 3. Minimum required face or edge clearances.
 4. Effective sealing between joints of glass-framing members.
- C. Do not proceed with glazing until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings that are not firmly bonded to substrates.
- B. Clean contact surfaces with solvent and wipe dry.
 1. Surface Preparation: Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- C. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- D. Prime surfaces scheduled to receive sealant.

3.3 GLAZING

- A. General: Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
1. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.
 2. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
 3. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
 4. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
 5. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
 6. Provide spacers for glass lites where length plus width is larger than 50 inches.
 7. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- B. Tape Glazing: Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
1. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
 2. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
 3. Apply heel bead of elastomeric sealant.
 4. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
 5. Apply cap bead of elastomeric sealant over exposed edge of tape.

- C. Gasket Glazing (Dry): Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
 - 1. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
 - 2. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
 - 3. Install gaskets so they protrude past face of glazing stops.

- D. Sealant Glazing (Wet): Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
 - 1. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
 - 2. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.4 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.
- B. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkaline despoil, or stains: remove as recommended by glass manufacturer.
- D. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer and as required in DIVISION 01 Execution Requirements.
 - 1. Remove labels after work is complete.

- E. Protect exterior glass from breakage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- F. Remove labels after work is complete.
- G. Comply with waste management and recycling program requirements.
- H. Dispose of material legally.

END OF SECTION

SECTION 089000 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fixed, extruded-aluminum louvers.

1.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors.
 - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- B. Seismic Performance: Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
 - 1. Design earthquake spectral response acceleration, short period (Sds) for Project is 0.49g.
 - 2. Component Importance Factor is 1.0.
- C. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
 - 1. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information. Submit air flow tests and compliance information for free area. Coordinate free area requirements with mechanical drawings. Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.
- B. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens, blankout areas required, and frames.
- C. Test Reports: Independent agency reports showing compliance with specified performance criteria.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Samples:

1. Selection of color: Submit complete set of manufacturer's product samples, demonstrating manufacturer's full range of standard and custom colors available for each product for Designer's selection.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store and handle louvers in a manner that they will not be damaged and to prevent deterioration from the elements.
- B. Store louvers and frame components at the site in a protected area to prevent damage by construction activities.

1.6 PROJECT CONDITIONS

- A. Coordinate work of this section with installation of mechanical ductwork.

1.7 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Provide (5) five year manufacturer's warranty against distortion, metal degradation, and failure of connections.
 1. Finish: Include coverage against degradation of exterior finish for (20) twenty years.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T5, or T6.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
 1. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 2. For color-finished louvers, use fasteners with heads that match color of louvers.

2.2 FABRICATION, GENERAL

- A. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- B. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.3 FIXED, EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal, Drainable-Blade Louver (general):
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties Inc., Model B5157, or an approved equal product by one of the following:
 - a. Air Flow Company, Inc.
 - b. Airolite Company, LLC (The).
 - c. Carnes Company, Inc.
 - d. Industrial Louvers, Inc.
 - e. Metal Form Manufacturing Inc.
 - f. NCA Manufacturing, Inc.
 - g. Nystrom Building Products.
 - h. Reliable Products, Inc.
 - 2. Louver Depth: 5 inches (125 mm).
 - 3. Frame and Blade Nominal Thickness: Not less than 0.081 inch (2.06 mm) at sills, jambs and mullions, 0.075 inch(1.91mm) at heads, and 0.081 inch(2.06mm) at fixed blades.
 - 4. Louver Performance Ratings:
 - a. Free Area: Not less than 8.42 sq. ft. (0.78 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
 - b. Point of Beginning Water Penetration: Not less than 1043 fpm (318.0 m/min).
 - c. Intake Pressure drop at the point of beginning water penetration: 0.45 in. H₂O (11.43 mm).
 - 5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
- B. Louver Screen Frames: Same kind and form of metal as indicated for louver to which screens are attached.
- C. Louver Screening:
 - 1. Bird Screening: Aluminum, 1/2-inch- (13-mm-) square mesh, 0.063-inch (1.60-mm) wire.

2.5 ALUMINUM FINISHES

- A High-Performance Organic Finish: 3-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat,

and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Color and Gloss: As selected by Designer from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Erection Tolerances:
 1. Maximum variation from plane or location shown on the approved shop drawings: 1/8" per 12 feet of length, but not exceeding 1/2" in any total building length or portion thereof (non-cumulative).
 2. Maximum offset from true alignment between two members abutting end to end, edge-to-edge in line or separated by less than 3": 1/16" (shop or field joints). This limiting condition shall prevail under both load and no load conditions.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect galvanized and nonferrous-metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint.
- F. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- G. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on shop drawings.
- H. Verify that field measurements are as indicated on shop drawings.

3.2 INSTALLATION

- A. Install louver assembly in accordance with manufacturer's instructions.
- B. Install louvers level and plumb.
- C. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
- D. Secure louver frames in openings with concealed fasteners.
- E. Install perimeter sealant and backing rod in accordance with Division 07.

3.3 CLEANING

- A. Strip protective finish coverings.
- B. Clean surfaces and components.
- C. Protect all adjacent surfaces from damage.
- D. Clean soiled surfaces immediately.
- E. Replace any damaged material which cannot be repaired with new material.
- F. Dispose of all waste legally and in accordance with local jurisdiction requirements.
- G. Comply with waste management and recycling program requirements.

END OF SECTION

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes non-load-bearing steel framing members for the following applications:
 - 1. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.).
 - 2. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.).

1.2 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.

1.3 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.

1.4 PERFORMANCE REQUIREMENTS:

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV.
 - a. Seismic Design Category: C.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second)(S_{DS}): 0.182.
 - 4. Design Spectral Response Acceleration at 1.0-Second Period S_{D1} : 0.064.

PART 2 - PRODUCTS

2.1 NON-LOAD-BEARING STEEL 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: ASTM A 653/A 653M, G40, hot-dip galvanized, unless otherwise indicated.

2.2 SUSPENSION SYSTEM COMPONENTS

- A. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch wide flanges.
 - 1. Depth: As indicated on Drawings.
- B. Furring Channels (Furring Members):
 - 1. Cold-Rolled Channels: 0.0538-inch bare-steel thickness, with minimum 1/2-inch wide flanges, 3/4 inch deep.
 - 2. Steel Studs: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.0179 inch.
 - b. Depth: 2-1/2 inches.
 - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
 - a. Minimum Base Metal Thickness: 0.0179 inch.

2.3 STEEL FRAMING FOR FRAMED ASSEMBLIES

- A. Steel Studs and Runners: ASTM C 645.
 - 1. Minimum Base-Metal Thickness: 0.027 inch.
 - 2. Depth: As indicated on Drawings.
- 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. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Metal Thickness: 0.027 inch² inch.
- E. Cold-Rolled Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch wide flanges.
1. Depth: As indicated on Drawings 1-1/2 inches.
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
1. Minimum Base Metal Thickness: As indicated on Drawings 0.0179 inch.
 2. Depth: As indicated on Drawings 7/8 inch.
- 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 nonslotted 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.

2.4 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.

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.
- B. Coordination with Sprayed Fire-Resistive Materials:
 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.

3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
 4. 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 SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.

5. Do not attach hangers to steel roof deck.
 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.5 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.
1. Space studs as follows:
 - a. Single-Layer Application: 16 inches o.c., unless otherwise indicated.
 - b. Multilayer Application: 16 inches o.c., unless otherwise indicated.
 - c. Tile backing panels: 16 inches o.c., unless otherwise indicated.
- 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. Firestop 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.
 - 6. Curved Partitions:
 - a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
 - b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of not less than 2 studs at ends of arcs, place studs 6 inches o.c.
- 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 07 Section "Thermal 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 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Exterior gypsum board for soffits.

B. Related Requirements:

1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.2 SUBMITTALS

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

D. Quality Assurance Submittals:

1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.3 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.4 FIELD CONDITIONS

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

- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Recycled Content of Gypsum Panel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include:
 - a. USG Corporation.
 - b. Georgia Pacific
 - c. CertainTeed Corporation
 - d. Or Approved Equal.
- B. Gypsum Wallboard: ASTM C 1396/C 1396M.
 - 1. Thickness: 1/2 inch
 - 2. Long Edges: Tapered.
- C. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch
 2. Long Edges: Tapered.
- D. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
1. Thickness: 1/2 inch
 2. Long Edges: Tapered.
- E. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces (provide in all toilet rooms, storage room G311, kitchen and nurses exam rooms).
1. Core: 5/8 inch, Type X.
 2. Long Edges: Tapered.
 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

- A. Exterior Gypsum Soffit Board (at soffit in conjunction with exterior louvers): ASTM C 1396/C 1396M, with manufacturer's standard edges.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include:
 - a. USG Corporation.
 - b. Georgia Pacific
 - c. CertainTeed Corporation
 - d. Or Approved Equal.
 2. Core: As indicated 5/8 inch, Type X.

2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
 2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.
- B. Exterior Trim: ASTM C 1047 (at soffit in conjunction with exterior louvers).

1. Material: Hot-dip galvanized-steel sheet, plastic, or rolled zinc.
2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
 2. Exterior Gypsum Soffit Board: Paper.
 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
 4. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
 3. Fill Coat: For second coat, use setting-type, sandable topping compound.
 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
 5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.
- D. Joint Compound for Exterior Applications:
 1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
 2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.
- E. Joint Compound for Tile Backing Panels:
 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
 2. Cementitious Backer Units: As recommended by backer unit manufacturer.

3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.7 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
 1. Laminating adhesive shall have a VOC content of 50 g/L or less.
 2. Laminating adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound-Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Accumetric LLC.
 - b. Grabber Construction Products.
 - c. Pecora Corporation.
 - d. Specified Technologies, Inc.
 - e. USG Corporation.
 - f. Or Approved Equal.
 2. Acoustical joint sealant shall have a VOC content of 250 g/L or less.

3. Acoustical joint sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
 - H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
 - I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.
 - J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
 - K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 1. Wallboard Type: As indicated on Drawings.
 2. Type X: As indicated on Drawings.
 3. Ceiling Type: As indicated on Drawings.
 4. Mold-Resistant Type: As indicated on Drawings.
- B. Single-Layer Application:
 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 2. On partitions/walls, apply gypsum panels perpendicular to framing unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.

- b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
- 3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
- 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

- 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
- 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
- 3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
- 4. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

- D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 APPLYING EXTERIOR GYPSUM PANELS FOR SOFFITS

- A. Apply panels perpendicular to supports, with end joints staggered and located over supports.
 - 1. Install with 1/4-inch open space where panels abut other construction or structural penetrations.
 - 2. Fasten with corrosion-resistant screws.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners unless otherwise indicated.
 - 2. Bullnose Bead: Use at outside corners.
- D. Exterior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners.
 - 2. LC-Bead: Use at exposed panel edges.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Panels that are substrate for tile.
 - 3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
 - 4. Level 5: All exposed wall locations.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
- F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 093000 – TILING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes, but is not limited to the following:

1. Tile for wall floor applications.
2. Cementitious Backer Units.

1.3 REFERENCE STANDARDS

- A. ANSI A108 Series/A118 Series/A136.1 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2005.
- B. TCA (HB) - Handbook for Ceramic Tile Installation; Tile Council of North America, Inc.; 2007/2008.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified as required to demonstrate compliance with specified requirements and provide complete application information.
- C. Samples: Mount tile and apply grout on two plywood panels, minimum 18 x 18 inches illustrating pattern, color variations, and grout joint size variations.
- D. Quality Assurance Submittals:
 1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 QUALITY ASSURANCE

- A. Manufacturer: Provide manufacturer's representative for consultation at Project Site with ceramic tile installer during ceramic tile installation as requested by the Engineer in consultation with the Owner Occupant.

- C. Installer: Minimum of least (8) years of experience in installation of ceramic tile applications similar to those indicated in this Project, and at least 5 successfully completed ceramic tile installations of similar scope, complexity and materials completed within (3) years prior to award of Contract.
 - 1. Provide thoroughly trained and experienced journeymen tile setters who are completely familiar with specified requirements and with recommendations in standards referenced in this Section.
 - 2. Contractor is advised that allowance will not be made in inspection of installed tile for lack of skill of tile setters.
- D. Maintain one copy of TCA Handbook and ANSI A108 Series/A118 Series on site.
- E. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum 10 years of documented experience.
- F. Installer Qualifications: Company specializing in performing tile installation, with minimum of 8 years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver materials and store on site in original containers with seals unbroken and labels intact until time of use, in accordance with manufacturer's directions.
- B. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.6 SPARE PARTS

- A. Furnish to the Engineer spare parts that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated

1.7 FIELD CONDITIONS

- A. Do not install adhesives in an unventilated environment.
- B. Maintain ambient and substrate temperature of 50 degrees F follow manufacturer's instructions during installation of mortar materials.

PART 2 - PRODUCTS

2.1 TILE

A. Available Manufacturers:

1. American Olean; Div. of Dal-Tile International Corp. (Basis of Design)
2. Other products that may be acceptable upon a compliance review includes:
Daltile; Div. of Dal-Tile International Inc.
Crossville Inc.
3. Single Source Responsibility: Provide materials obtained from only 1 source for each type of tile, mortar, grout and color to minimize variations in appearance and quality.

B. Porcelain Mosaic Floor Tile – **FT1**: Factory-mounted flat tile as follows:

1. Composition: Vitreous or impervious natural clay or porcelain.
2. Surface: Slip-resistant, with abrasive admixture.
3. Module Size: 12"x24".
4. Pattern: Stack Bond Pattern.
5. Nominal Thickness: 1/4 inch.
6. Face: Plain with cushion edges.
7. Color selected by Designer in consultation with Owner Occupant from price group 1, 2 or 3.

B. Porcelain Mosaic Wall Tile – **WT1**: Factory-mounted flat tile as follows:

1. Composition: Vitreous or impervious natural clay or porcelain.
2. Surface: Slip-resistant, with abrasive admixture.
3. Module Size: 12"x24".
4. Pattern: Stack Bond Pattern.
5. Nominal Thickness: 1/4 inch.
6. Face: Plain with cushion edges.
7. Color selected by Designer in consultation with Owner Occupant from price group 1, 2 or 3.

C. Glazed Wall Tile (At breakroom back splash, behind refrigerator and restroom walls): Flat tile as follows:

1. Field and Accent Module Size: 3" x 6".
 - a. Thickness: 5/16 inch.
 - b. Finish: Bright glaze. As selected by Designer in consultation with Owner Occupant from price group 1, 2 or 3.
 - c. Wall Tile: Tile colors for field tile and accent wall tile #2 as selected by Designer in consultation with Owner Occupant from full range of colors from price group 1, 2, or 3.
2. Face: Plain with modified square edges or cushion edges.
3. Mounting: Factory back-mounted.
4. Pattern: Stretcher Bond Pattern.
5. External Corners for Thin-Set Mortar Installations: Surface bullnose.

6. Internal Corners: Field-buttet square corners except with coved base and cap angle pieces designed to fit with stretcher shapes.

2.2 SETTING AND GROUTING MATERIALS

A. Manufacturers:

1. LATICRETE International Inc.
2. Bostik Findley.
3. MAPEI Corporation.

2.4 ADHESIVE MATERIALS

A. Manufacturers:

1. As recommended by manufacturer and in accordance with all VOC content levels.

- ### B. Organic Adhesive: ANSI A136.1, thin set bond type; use Type I in areas subject to prolonged moisture exposure.

2.5 MORTAR MATERIALS

A. Manufacturers:

1. As recommended by manufacturer and in accordance with all VOC content levels. Refer to specification divisions.
2. Latex Portland Cement Thin Bed Mortar for thin set and slurry bond coats to be weather, frost, shock resistant, non-flammable and to meet the following physical requirements:
 - a. Compressive strength (ANSI A118.4): 2400 psi (16.5 MPa) Min.
 - b. Bond strength (ANSI A118.4): 500 psi (3.5 MPa) Min.
 - c. Smoke and Flame Contribution (ASTM E84 Modified): 0.
 - d. Similar to LATICRETE 254 Platinum Multipurpose Thin-Set Mortar as manufactured by LATICRETE International, Inc. or approved equal.
3. Latex Portland Cement Mortar for thick beds, screeds, leveling beds and scratch/plaster coats to be weather, frost, shock resistant and meeting the following physical requirements:
 - a. Compressive strength (ANSI A118.4): 5000 psi (34.5 MPa) Min.
 - b. Water absorption (ANSI A118.6): $\leq 5\%$.
 - c. Smoke and Flame Contribution (ASTM E84 Modified): 0.
 - d. Similar to LATICRETE 226 Thick Bed Mortar gauged with LATICRETE 3701 Mortar Admix as manufactured by LATICRETE International, Inc. or approved equal.

2.6 GROUT MATERIALS

A. Manufacturers:

1. As recommended by manufacturer for application on project and in accordance with all sustainable criteria in specification Division 01.
2. Epoxy Grout (Commercial) shall be non-toxic, non-flammable, non-hazardous during storage, mixing, application and when cured and shall meet the following physical requirements:
 - a. Compressive Strength (ANSI A118.3): 3500 psi (24 MPa)
 - b. Shear Bond Strength (ANSI A118.3): 1000 psi (6.9 MPa)
 - c. Water Absorption (ANSI A118.3): < 0.5 %
 - d. Cured Epoxy Grout to be chemically and stain resistant to ketchup, mustard, tea, coffee, milk, soda, beer, wine, bleach (5% solution), ammonia, juices, vegetable oil, brine, sugar, cosmetics, and blood, as well as chemically resistant to dilute acids and dilute alkalis.
 - e. Similar to LATICRETE SpectraLock™ Pro Grout as manufactured by LATICRETE International, Inc. or approved equal.

PART 3 - PRODUCTS

EXECUTION

3.1 EXAMINATION:

- A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until satisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 PREPARATION

- A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
- B. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions.
- C. Remove protrusions, bumps, and ridges by sanding or grinding.
- D. Blending: For tile exhibiting color variations, use factory blended tile or blend tiles at Project site before installing.
- E. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, pre-coat

them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

- F. Prepare open joints and tile edges to receive sealant. All surfaces to be dry and clean prior to setting of sealant. Use sealant recommended by tile manufacturer and in accordance with TCA installation methods for conditions encountered on site to obtain an optimum bond.
- G. Prime all tile edges to receive sealant in accordance with the manufacturer's installation guidelines and keep primer off of all finished faces / edges of tile.

3.3 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. TCA Installation Guidelines: Current version of TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Manufacturer's Installation Guidelines: Follow the manufacturer's installation guidelines for installation, VOC requirements and sustainable guidelines in accordance with Division 01.
- D. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments. Tile to be full height on walls. Extend tile from finished floor to a minimum of 6 inches above ceiling.
- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Grind cut edges of tile abutting trim, finish, or built-in items. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- F. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
- G. Movement/Expansion Joints: Locate expansion joints and other sealant-filled joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Locate joints in tile surfaces directly above joints in concrete substrates.

2. Prepare joints and apply sealants as per manufacturer's recommendations and to comply with requirements in Division 7 Section "Joint Sealants."
 3. Provide joints according to TCA EJ171 Movement Joint Design.
 4. Maximum spacing of movement joints to be 20' maximum on center.
 5. Where tile abuts restraining surfaces such as perimeter walls, dissimilar floors, curbs, columns, pipes ceilings, and where changes occur in backing materials. Not at drain strainers.
 6. All expansion, control, construction, cold, and seismic joints in the structure should continue through the tile work, including such joints at vertical surfaces, or provide approved movement joints to allow for movement thru separation membrane / backing material.
 7. Interior joint widths in ceramic glazed wall tile joints 1/8" to 1/4".
 8. Joints in tile and setting materials shall never be less than the width of the saw-cut control joint width.
- H. Grout tile to comply with requirements of ANSI A108.10, unless otherwise indicated.
1. For chemical-resistant epoxy grouts, comply with ANSI A108.6.
- I. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
1. Tile floors in wet areas.
 2. Tile floors composed of tiles 8 by 8 inches or larger.
 3. Tile floors composed of rib-backed tiles.
- J. Install tile on floors with the following joint widths: 1/8 inch or as selected by the Designer in consultation with the Owner Occupant.
- K. Wall Tile: Install wall tile over level, plumb, and true wall surfaces. Level and plumb wall surfaces prior to installation of wall tile. Utilize patching and leveling material recommended by mortar and grout manufacturer for application. Joint widths should be 1/8 inch or 1/16 inch for mosaics or as selected by the Designer in consultation with the Owner Occupant.
- L. Stone Thresholds @ Toilet Rooms: Install stone thresholds at locations indicated; set in same type of setting bed as abutting field tile, unless otherwise indicated.
1. Set thresholds in latex-portland cement mortar for locations where mortar bed would otherwise be exposed above adjacent non-tile floor finish.
- M. Install tile on walls with the following joint widths:
1. Glazed Wall Tile: 1/16 inch or 1/8 inch maximum as selected by the Designer in consultation with the Owner Occupant.

3.4 FLOOR TILE INSTALLATION

- A. Refer to TCA handbook for installation method related to project conditions as referenced below.
- B. Interior floor installation on concrete; cement mortar bed (thickset); TCA F112, or approved equal.
 - 1. Bond Coat/Mortar: Latex - Portland cement mortar.
 - 2. Grout: 100% Epoxy grout.

3.5 WALL TILE INSTALLATION

- A. Cementitious backer units and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-Portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.
- B. Interior wall installation over tile backer board (cementitious backer units); thin-set mortar; TCA W244, or approved equal.
 - 1. Thin-Set Mortar: Latex - Portland cement mortar.
 - 2. Grout: 100% Epoxy grout.

3.6 GUIDELINES FOR INSTALLATION

- A. Comply with applicable ANSI standard installation specifications A108 Series and specified TCA "Handbook for Ceramic Tile Installation" specifications. Handle, store, mix and apply proprietary setting and grouting materials in compliance with manufacturer's instructions.
 - 1. Extend tile work into recesses and under equipment and fixtures, to form complete covering without interruptions, except as otherwise shown. Terminate work neatly at obstructions, edges, and corners without disruption of pattern or joint alignment.
 - 2. For tile on walls and floors comply with ANSI requirements for installation of tile.
- B. Setting Beds: Provide setting beds in accordance with applicable TCA specification or match adjacent work in alterations, unless otherwise specified.
- C. Jointing Pattern: Unless otherwise required for matching, lay wall tile in grid pattern. Align joints when adjoining tiles on floor; base walls and trim are same size. Layout tile work and center tile fields both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths. Coordinate layout with tile patterns issued by Architect during construction sequence.

- D. Marble Threshold Installation: Thoroughly clean concrete slab before setting marble. Set level and square in full mortar setting bed. Use materials and methods providing full uniform bearing on setting bed, firm bonding to substrate and marble, and no staining of marble. Fill end joints with grout made non-staining white Portland cement.

3.7 ADJUSTING/PROTECTION/CLEANING

- A. Cleaning: Clean unglazed tile with acid solutions only when permitted by tile and grout manufacturer's printed instructions, but not sooner than (10) days after installation. Leave finished installation clean and free of cracked, chipped, broken, un-bonded, or otherwise defective tile. Clean excess mortar/epoxy from veneer surfaces with water before they harden and as work progresses. Do not contaminate open grout/caulk joints while cleaning. Sponge and wash veneers diagonally across joints. Polish with clean dry cloth. Remove surplus materials and leave premises broom clean.
- B. Protection: Protect installed ceramic tile in accordance with manufacturer's instructions. Provide minimum protection with kraft paper or other heavy covering during construction period to prevent damage and wear. Prohibit foot and wheel traffic from using tiled floors for at least (4) days after grouting is completed. Before final inspection, remove protective coverings and rinse cleaner from tile surfaces. Use kneeling boards, or equivalent, to walk/work on newly tiled floors. Extend period of protection of tile work at lower temperatures, below 60°F (15°C), and at high relative humidity (>70% R.H.) due to retarded set times of mortar/adhesives. Replace or restore work of other trades damaged or soiled by work under this section.
 - 1. Epoxy Adhesive: Keep floors installed with epoxy adhesive closed to traffic for 24 hrs. at 70°F, and to heavy traffic for 48 hours @ 70°F unless instructed differently by manufacturer.

END OF SECTION

SECTION 095113 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.2 DEFINITIONS:

- A. AC: Articulation Class.
- B. CAC: Ceiling Attenuation Class.
- C. LR: Light-Reflectance coefficient.
- D. NRC: Noise Reduction Coefficient.

1.3 COORDINATION:

- A. Coordinate location of mechanical, plumbing, electrical and cable tray work within all ceiling cavity areas, including the area above the acoustical ceiling systems to the underside of the existing concrete decking to prevent interference with all building systems within that space.
- B. Mark locations using the acoustical ceiling system grid to enable mechanical, plumbing, electrical and cable tray work to proceed without interferences within the ceiling cavity.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
- C. Delegated-Design Submittal: For Acoustical Panel **ACP-3** ceiling signed and sealed by the qualified professional engineer.
 - 1. Indicate compliance with performance requirements and design criteria, including analysis data.
 - 2. The Acoustical Panel ACP-3 ceiling shall utilize specially connectors and attachment methods as required by manufacturer to provide design criteria.
 - 3. The Acoustical Panel ACP-3 ceiling shall provide flexible and reconfigurable overhead cable tray and electrical distribution without separate strut channel system.
 - 4. Indicate the Following on Reflected Ceiling Plans:

- a. **ACP-3** shall be design to provide Supports point loads up to 300 lbs. using 3/8" threaded rod and integrated hanging clips to provide:
 - b. Include all support drop rod locations and attachment to existing cellular decking system or miscellaneous steel support.
 - c. Include all support locations for cable tray support and attachment ACP-3.
 - d. Method of attaching hangers to building structure or building system.
 - e. Coordinated drawings with all other ceiling-mounted items including light fixtures, diffusers, grilles, sprinklers, and access panels.
- D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
- 1. Suspended ceiling components indicating coordination with general construction, building components, mechanical systems, and other building services.
 - 2. Structural members to which elements of construction will be attached.
 - 3. Size and location of initial access modules for acoustical panels.
 - 4. Size and location of items penetrating finished ceilings including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings
 - 5. Ducts associated with HVAC systems.
 - 6. Penetrations of smoke barriers and fire-rated construction.
 - 7. Piping associated with HVAC, plumbing, and fire protection systems.
 - 8. Electrical conduits and cable trays.
- The Contractor and each Installer shall approve (sign-off on) the Coordination Drawings prior to their submission.
- E. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
- F. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
- 1. Acoustical Panel: Set of full-size Samples of each type, color, pattern, and texture.
 - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch long Samples of each type, finish, and color.
- G. FM-Global Requirements: Use non-combustible or FM Approved Class 1 acoustical ceiling panels shall be provided.

H. Quality Assurance Submittals:

1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.
- D. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

1.7 SPARE PARTS:

- A. Furnish to the Engineer spare parts that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Acoustical Panels: 25% extra.
 - a. 5% extra for ACP1, 24 by 24
 - b. 3.5% extra for ACP2A, 24 by 48
 - c. 3.5% extra for ACP2B, 24 by 48
 - d. 1.5% extra for ACP2A, 12 by 48
 - e. 1.5% extra for ACP2B, 12 by 48
 - f. 5% extra for ACP3, 24 by 24
 - g. 2% extra for ACP4, 24 by 24
 - h. 3% extra for ACP5A & ACP5B, 24 by 48
 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
 3. Hold-Down Clips: Equal to 2 percent of quantity installed.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV.
 - a. Seismic Design Category. C.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second)(S_{DS}): 0.182.
 - 4. Design Spectral Response Acceleration at 1.0-Second Period S_{DI} : 0.064.
- C. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 - 2. Smoke-Developed Index: 50 or less.
- D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Low-Emitting Materials: Acoustical panel ceilings 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. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
 - 2. Suspension System: Obtain each type from single source from single manufacturer.

- C. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
- D. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.
- E. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.
- F. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

- A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
 - 1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled bonded anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
 - c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
 - d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 for UNS No. N04400 alloy.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch diameter wire.
- E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch diameter bolts.
- F. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.
- G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.
- H. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place.
- I. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.
- J. Clean-Room Gasket System: Where indicated, provide manufacturer's standard system, including manufacturer's standard gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

2.4 ACOUSTICAL PANELS **ACP-1**

- A. As a basis of design, details and specifications have been based on Armstrong World Industries, Lyra with High NRC Ceiling. Other Manufacturer's that may be acceptable upon a compliance review include:
1. USG Corporation:
 2. CertainTeed:

- A. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:
1. Pattern: As indicated by manufacturer's designation.
 2. Type and Form: Type III, mineral base with painted finish; Form 1, nodular.
 3. Compatible with Techzone ceiling
 4. Color: White.
 5. NRC: Not less than 0.95.
 6. CAC: Not less than 44.
 7. Thickness: 1 ¾" inch
 8. Edge: Beveled Tegular
 9. Modular Size: 24 by 24 inches as indicated on Drawings.
 10. Bioblock Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
- B. Suspension System: as a basis of design, details and specifications have been based on Armstrong World Industries, Superfine XL 9/16" Square Tegular. Other Manufacturer's that may be acceptable upon a compliance review include:
1. USG Corporation:
 2. CertainTeed:
- C. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than Z90 coating designation; with prefinished 9/16-inch wide metal caps on flanges.
1. Structural Classification: ASTM C 635 Heavy-duty system.
 2. End Condition of Cross Runners: butt-edge type.
 3. Face Design: Flat, flush
 4. Cap Material: aluminum cold-rolled sheet.
 5. Cap Finish: Painted White

2.5 ACOUSTICAL PANELS **ACP-2A & ACP-2B**

- A. For acoustical panels **ACP-2A**, the basis of design, details and specifications have been based on Armstrong World Industries, Lyra with High NRC Ceiling. Other Manufacturer's that may be acceptable upon a compliance review include:
1. USG Corporation:
 2. CertainTeed:
- B. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:

1. Pattern: As indicated by manufacturer's designation.
 2. Type and Form: Type III, mineral base with painted finish; Form 1, nodular.
 3. Compatible with Techzone ceiling
 4. Color: White.
 5. NRC: Not less than 0.95.
 6. CAC: Not less than 44.
 7. Thickness: 1 3/4" inch
 8. Edge: Beveled Tegular
 9. Modular Size: 24 by 48 and 6 by 48 inches as indicated on Drawing.
 10. Bioblock Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
- C. For acoustical panels **ACP-2B**, the basis of design, details and specifications have been based on Armstrong World Industries, Calla Ceiling. Other Manufacturer's that may be acceptable upon a compliance review include:
1. USG Corporation:
 2. CertainTeed:
- D. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:
1. Pattern: As indicated by manufacturer's designation.
 2. Type and Form: Type III, mineral base with painted finish; Form 1, nodular.
 3. Color: White.
 4. NRC: Not less than 0.85.
 5. CAC: Not less than 35.
 6. Thickness: 1 inch.
 7. Edge: Beveled Tegular
 8. Modular Size: 24 by 24 inches as indicated on Drawing.
- E. Suspension System: as a basis of design, details and specifications have been based on Armstrong World Industries, Superfine XL 9/16" Square Tegular. Other Manufacturer's that may be acceptable upon a compliance review include:
1. USG Corporation:
 2. CertainTeed:
- F. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than Z90 coating designation; with prefinished 9/16-inch wide metal caps on flanges.
1. Structural Classification: ASTM C 635 Heavy-duty system.
 2. End Condition of Cross Runners: butt-edge type.

3. Face Design: Flat, flush
4. Cap Material: aluminum cold-rolled sheet.
5. Cap Finish: Painted White

2.6 ACOUSTICAL PANELS **ACP-3**

- A. As a basis of design, details and specifications have been based on Armstrong World Industries, Calla Ceiling. Other Manufacturer's that may be acceptable upon a compliance review include:
 1. USG Corporation:
 2. CertainTeed:
- B. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:
 1. Pattern: As indicated by manufacturer's designation.
 2. Type and Form: Type III, mineral base with painted finish; Form 1, nodular.
 3. Color: White.
 4. NRC: Not less than 0.85.
 5. CAC: Not less than 35.
 6. Thickness: 1 inch
 7. Edge: Beveled Tegular
 8. Modular Size: 24 by 24 inches as indicated on Drawing.
- C. Suspension System: as a basis of design, details and specifications have been based on Armstrong World Industries, Prelude XL MAX 15/16" Exposed Tee. Other Manufacturer's that may be acceptable upon a compliance review include:
 1. USG Corporation:
 2. CertainTeed:
- D. Components: Main beams and cross tees, base metal and end detail, fabricated from commercial quality hot dipped galvanized steel complying with ASTM A 653. Main beams and cross tees are double-web steel construction with 15/16" flange type exposed flange design. Exposed surfaces chemically cleansed, capping prefinished galvanized steel in baked polyester paint. Main beams and cross tees shall have rotary stitching with a double stacked PeakForm construction.
- E. Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 15/16-inch- wide metal caps on flanges.
 1. Structural Classification: ASTM C 635 Heavy-duty system.
 2. End Condition of Cross Runners: butt-edge type.
 3. Face Design: Flat, flush.
 4. Cap Material: aluminum cold-rolled sheet.

5. Cap Finish: Painted White
6. Main beams: Length 12ft. web height 2 7/16" with peaked roof top bulb and 15/16 inch bottom flange
7. Cross tee: Length 4ft. web height 2 7/16 inch" with peaked roof top bulb and 15/16 inch bottom flange
8. Cross Tee: Length 2ft. web height 2 7/16" with peaked roof top bulb and 15/16 inch bottom flange

F. Edge Moldings and Trim: Structural Wall Angle Length 12ft. 7/8: width

G. Suspension System Accessories:

1. Intersection Hanging Clip (IHC) - Increases main beam to cross tee connection strength and carry system load with 3/8" threaded rod from structure.
2. Prelude XL Max Load Connector (PMLC) - Supports bus bar, cable trays and other components with 3/8" threaded rod along the suspension system face.
3. Intersection Joint Clip (IJCA) - Increases main beam to cross tee connection strength.
4. Cross Tee Adapter Clip (XTAC) - Attaches cross tee or main beams to the structural wall molding.
5. Supplemental Hanging Clip (SHC) - Carries the system load with 3/8" threaded rod from structure when plenum obstructions prevent the use of the IHC Clip.
6. Top Lock Main Beam Splice Clip (TLMS) - Locks two main beams together for a secure connection.
7. Prelude XL Max Hold Down Clip (PMHDC) - Holds ceiling planes in place, helps prevent ceiling panel movement.

H. General Component Accessories

1. Imperial 3/8" Threaded Rod, low-strength steel
2. Imperial 3/8"-16 Heavy Hex Nuts ANSI/ASME B18.2.2 Grade 2, 11/16" width, 23/64" height.
3. Imperial 3/8"-16 Heavy Hex Locknuts, Grade 2, 11/16" Width, 35/64 Height.
4. Imperial 3/8" Flat Washer, 1/8" Thickness, 7/8" Width, Case Hardened Steel, Grade C-1010
5. Imperial Blind Steel Pop Rivets 1/8" Diameter x .337" Long, .126"-.186" Grip Range. Shear Strength: 260 lbs. IFI 114 Grade 30, Size Code 43

I. Attachment Devices

1. Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

2.7 ACOUSTICAL PANELS **ACP-4**

A. As a basis of design, details and specifications have been based on Armstrong World Industries, Calla Ceiling. Other Manufacturer's that may be acceptable upon a compliance review include:

1. USG Corporation:
 2. CertainTeed:
- B. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:
1. Pattern: As indicated by manufacturer's designation.
 2. Type and Form: Type III, mineral base with painted finish; Form 1, nodular.
 3. Color: White.
 4. NRC: Not less than 0.85.
 5. CAC: Not less than 35.
 6. Thickness: 1 inch
 7. Edge: Beveled Tegular
 8. Modular Size: 24 by 24 inches as indicated on Drawings.
 9. Bioblock Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
- C. Suspension System: as a basis of design, details and specifications have been based on Armstrong World Industries, Superafine XL 9/16" Square Tegular. Other Manufacturer's that may be acceptable upon a compliance review include:
1. USG Corporation:
 2. CertainTeed:
- D. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than Z90 coating designation; with prefinished 9/16-inch wide metal caps on flanges.
1. Structural Classification: ASTM C 635 Heavy-duty system.
 2. End Condition of Cross Runners: butt-edge type.
 3. Face Design: Flat, flush
 4. Cap Material: aluminum cold-rolled sheet.
 5. Cap Finish: Painted White

2.8 ACOUSTICAL PANELS **ACP-5A** & **ACP-5B**

- A. As a basis of design, details and specifications have been based on Armstrong World Industries, Calla Ceiling. Other Manufacturer's that may be acceptable upon a compliance review include:
1. USG Corporation:
 2. CertainTeed:

- B. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:
1. Pattern: As indicated by manufacturer's designation.
 2. Type and Form: Type III, mineral base with painted finish; Form 1, nodular.
 3. Color: White.
 4. NRC: Not less than 0.85.
 5. CAC: Not less than 35.
 6. Thickness: 1 inch
 7. Edge: Beveled Tegular
 8. Modular Size: 24 by 48 inches as indicated on Drawings.
 9. Bioblock Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.
- C. Suspension System: @ **ACP-5A** the existing system to remain.
- D. Suspension System: @ **ACP-5B** the basis of design, details and specifications have been based on Armstrong World Industries, Superafine XL 9/16" Square Tegular. Other Manufacturer's that may be acceptable upon a compliance review include:
1. USG Corporation:
 2. CertainTeed:
- E. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than Z90 coating designation; with prefinished 9/16-inch wide metal caps on flanges.
1. Structural Classification: ASTM C 635 Heavy-duty system.
 2. End Condition of Cross Runners: butt-edge type.
 3. Face Design: Flat, flush
 4. Cap Material: aluminum cold-rolled sheet.
 5. Cap Finish: Painted White

2.9 METAL EDGE MOLDINGS AND TRIM

- A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.

2. Provide manufacturer's standard perimeter trim to accommodate acoustical panel ceilings height transitions, similar to axiom trim by Armstrong or approved equal. Trim shall match acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
 3. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
 4. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.
 2. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
 3. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 - 1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 8. Do not attach hangers to steel deck tabs.
 - 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.

11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
 - D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
 - E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
 - F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 1. Arrange directionally patterned acoustical panels as follows:
 - a. As indicated on reflected ceiling plans.
 - b. Install panels with pattern running in one direction parallel to long axis of space.
 - c. Install panels in a basket-weave pattern.
 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
 3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
 5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 6. Install hold-down clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions unless otherwise indicated.
 7. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.

8. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections of completed installations of acoustical panel ceiling hangers and anchors and fasteners in successive stages. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations show compliance with requirements.
 1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.
 - a. Within each test area, testing agency will select one of every 10 power-actuated fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
 - b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- B. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096500 - RESILIENT FLOORING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes but is not limited to the following:
 - 1. Resilient tile flooring.
 - 2. Resilient base.
 - 3. Resilient accessories.
 - 4. Installation accessories.

1.2 REFERENCE STANDARDS

- A. ASTM F 710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2008.
- B. ASTM F 1861 - Standard Specification for Resilient Wall Base; 2002.
- C. BAAQMD 8-51 - Bay Area Air Quality Management District Regulation 8, Rule 51, Adhesive and Sealant Products; www.baaqmd.gov; current edition.
- D. CAL (CHPS LEM) - Low-Emitting Materials Product List; California Collaborative for High Performance Schools (CHPS); current edition at www.chps.net/manual/lem_table.htm.
- E. FS RR-T-650 - Treads, Metallic and Nonmetallic, Skid Resistant; Federal Specifications and Standards; Revision E, 1994.
- F. GEI (SCH) - GREENGUARD "Children and Schools" Certified Products; GREENGUARD Environmental Institute; current listings at www.greenguard.org.
- G. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.

- D. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- E. Shop Drawings: Indicate seaming plan.
- F. Selection Samples: Submit manufacturer's color samples for colors indicated on the contract drawings for Designer's review.
- G. Concrete Testing Standard: Submit a copy of ASTM F 710.
- H. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.
- I. Maintenance Data: For sound masking systems to include in maintenance manuals to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.
- J. Quality Assurance Submittals:
 - 1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 QUALITY ASSURANCE

- A. Single Source of Supply: Obtain each type and color of base and accessory from single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of Project.
- B. Installer Qualifications: Installer to be certified by manufacturer with a minimum of (5) years of in service experience. Provide evidence of five (5) successful projects. Provide owner name, contact information, project location and scope description along with manufacturer certification.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver base and accessories to Project site in original manufacturer's unopened cartons and containers each bearing names of product and manufacturer, Project identification, and shipping and handling instructions.
- B. Storage and Protection
 - 1. Store product in dry spaces protected from weather with ambient temperatures maintained between 50 Degrees F and 90 Degrees F.
 - 2. Move products into spaces where they will be installed at least 48 hours in advance of installation.

1.7 PROJECT / SITE CONDITIONS

- A. Maintain temperatures within range recommended by manufacturer, but not less than 70 Degrees F or more than 95 Degrees F, in spaces to receive floor products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. Do not install products until they are at the same temperature of the space they are to be installed in.
- C. After post-installation period, maintain temperatures within range recommended by manufacturer, but not less than 55 Degrees F or more than 95 Degrees F.
- D. Install resilient products after other finishing operations, including painting, have been completed.
- E. Maintain room temperature at minimum of 55 Degrees F.

1.8 SPARE PARTS

- A. Furnish to the Engineer spare parts that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - a. Extra Flooring Material: 50 S.F. of each type and color.
 - b. Extra Wall Base: 100 linear feet of each type and color.

1.9 SEQUENCING AND SCHEDULING

- B. Close spaces to traffic during installation.
- C. Sequence installing products specified in this Section with other construction to minimize possibility of damage and soiling during remainder of construction period.

PART 2 - PRODUCTS

2.0 GENERAL

- A. Flooring, Adhesives and Sealants: Adhesives and sealants are certified for low VOCs by the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," include 2004 Addenda or are certified as low VOC by one of the following:
 - 1. Scientific Certification Systems FloorScore (flooring products)
 - 2. Scientific Certification Systems – Indoor Advantage-Gold

3. GREENGUARD Certification Program
4. Green Seal GX-36 (adhesives and sealants)

2.1 FLOORING

- A. Floor Tile: 24 x 24 inch, Roundel solid color rubber tile.
 1. Material: Rubber.
 2. Nominal Thickness: 0.125 inch.
 3. Pattern: Hammered texture
 4. Color: As selected by Designer from full range of standard and premium colors including the A, B and C color palettes.
 5. Pattern: As directed by Designer, assume 100% field tile.
 6. Manufacturers:
 - a. Johnsonite, Inc: www.johnsonite.com. – Basis of Design or approved equal

2.2 RESILIENT BASE

- A. Resilient Base: ASTM F 1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove, and as follows:
 1. Height: 4 inch.
 2. Thickness: 0.125 inch thick.
 3. Finish: Satin.
 4. Length: Roll.
 5. Color: See contract drawings for finishes.
 6. Manufacturers:
 - a. Johnsonite, Inc: www.johnsonite.com. – Basis of Design

Other manufacturer's that may be acceptable upon a compliance review include:

- b. Burke Flooring: www.burkemercer.com.
- c. Roppe Corp: www.roppe.com.
- d. Or Approved Equal.

2.3 RESILIENT FLOORING ACCESSORIES

- A. Accessories: Provide accessory products specified below in color as selected by Designer from manufacturer's full range of colors. Confirm field conditions on site are suitable for products and profiles specified below before ordering. Modify profiles to suit field conditions encountered. Submit products with shop drawing and material schedule identifying location and use for product and profile and obtain Designers approval before ordering.
 5. Carpet Tile to Resilient Flooring / Rubber Floor transition:
 - a. "CTA-XX-K" by Johnsonite or approved equal.
 6. Provide alternative profiles as required to meet field conditions encountered, submit in shop drawings.

2.6 ACCESSORIES

- A. Sub floor Filler: White premix latex; type recommended by adhesive material manufacturer.
- B. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.
 - 1. Provide only products having lower volatile organic compound (VOC) content than required by the more stringent of the South Coast Air Quality Management District Rule No.1168 and the Bay Area Air Quality Management District Regulation 8, Rule 51 and in accordance with all sustainable requirements listed in specification Division1.
- C. Filler for Coved Base: As per manufacturer's recommendations and in accordance with all sustainable specifications and recommendations.
- D. Concrete Slab Primer: Non-staining type recommended by flooring manufacturer.
- E. Trowelable Underlayments: Latex-modified, Portland-cement-based formulation provided or approved by tile manufacturer for applications shown on Drawings.
- F. Concrete Floor Patching and Leveling Materials acceptable to the flooring system manufacturer or approved equal: (Select one of the following patching methods to address field conditions):
 - 1. Flash Patching: Portland cement-based self-drying cementitious flash patching material similar to "Ardex SD-F Feather Finish".
 - 2. Patching: Portland cement-based self-drying cementitious patching material similar to "Ardex SD-P Insta-Patch".
 - 3. Self-Leveling: Portland cement-based cementitious self-leveling material similar to "Ardex K-15".
- G. Adhesives (Cements): Water-resistant type recommended by tile manufacturer to suit resilient floor tile products and substrate conditions.
- H. Sealer: As recommended by manufacturer, provide topical sealer on products. Sealer to be a high quality cross linked acrylic floor polish containing 16% to 25% solids. Sealer to be installed over all resilient floors upon completion of installation prior to Owner's occupancy. Install sealer in accordance with the manufacturer's recommended installation instructions and installation guidelines of the floor product manufacturer. Sealer to confirm to slip resistant coefficients required by ADA.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- C. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
- D. Verify that concrete sub-floor surfaces are dry enough and ready for resilient flooring installation by testing for moisture emission rate and alkalinity in accordance with ASTM F 710; obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- E. Verify that required floor-mounted utilities are in correct location.

3.2 PREPARATION

- A. Surface Preparation: Comply with manufacturer's installation specifications for preparing substrates indicated to receive products indicated.
 - 1. Use trowelable leveling and patching compounds per flooring accessory manufacturer's directions to fill cracks, holes, and depressions in substrates.
 - 2. Use stair tread nose filler per tread manufacturer's directions to fill nosing substrates not conforming to tread contours.
 - 3. Remove coatings, including curing compounds, and other substances that are incompatible with flooring adhesives and that contain soap, wax, oil, or silicone, by using terrazzo or concrete grinder, drum sander, or polishing machine equipped with heavy-duty wire brush.
 - 4. Broom or vacuum clean substrates to be covered immediately before installing products specified in this Section. Following cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust.
 - 5. Apply concrete slab primer, if recommended by flooring accessory manufacturer, prior to applying adhesive. Apply according to manufacturer's directions.
- B. Prepare sub-floor surfaces as recommended by flooring and adhesive manufacturers.
- C. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.
- D. Prohibit traffic until filler is cured.

- E. Clean substrate.

3.3 INSTALLATION

- A. Starting installation constitutes acceptance of sub-floor conditions.
- B. Install all products in accordance with manufacturer's instructions.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Fit joints tightly.
- E. Set flooring in place; press with heavy roller to attain full adhesion.
- F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated on contract documents.
 - 1. Resilient Strips: Attach to substrate using adhesive.
- H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.4 TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless manufacturer's instructions say otherwise.
- B. Lay flooring with joints and seams parallel to building lines to produce symmetrical tile pattern.
- C. Install tile in accordance with manufacturer's installation requirements.
- D. Allow minimum 1/2 full size tile width at room or area perimeter.

3.5 RESILIENT BASE

- A. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient wall base with manufacturer's recommended adhesive filler material.
 - 1. Inside and Outside corner installation:
 - a. Job-Formed Corners:
 - 1) Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends. Shave back of base

at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.

- 2) Inside Corners: Use straight pieces of maximum lengths possible. Form by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.
- B. Fit joints tightly and make vertical. Maintain minimum dimension of 72 inches between joints.
 - C. At external corners, use premolded units. At exposed ends, use premolded units.
 - D. Install base on solid backing. Bond tightly to wall and floor surfaces.
 - E. Scribe and fit to door frames and other interruptions.

3.6 RESILIENT ACCESSORIES

- A. Resilient Accessory Installation: Comply with manufacturer's installation instructions. Place resilient accessories so that they are butted to adjacent materials of type indicated and bond to substrates with adhesives. Install reducer strips at edges of flooring that otherwise would be exposed.

3.8 CLEANING

- A. Perform following operations immediately after completing installation
 1. Remove visible adhesive and other surface blemishes using cleaner recommended by manufacturer.
 1. Sweep or vacuum floor thoroughly.
 2. Do not wash floor until after time period recommended by manufacturer.
 3. Damp-mop tile to remove black marks and soil.
- F. Remove excess adhesive from floor, base, and wall surfaces without damage.
- G. Clean in accordance with manufacturer's instructions and in accordance with all sustainable requirements listed in specifications section 01.
- H. Comply with waste management and recycling program requirements.
- I. Dispose of all materials legally.

3.9 PROTECTION

- A. Protect all flooring and accessories against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods indicated or recommended by tile manufacturer.
 - 1. Cover resilient accessories with un-dyed, untreated building paper until inspection for Substantial Completion.
- B. Clean products not more than 4 days prior to dates scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Clean using method recommended by tile manufacturer.
- C. Dispose of waste legally and in accordance with local jurisdiction requirements.
- D. Prohibit traffic on resilient flooring for 48 hours after installation. Replace all damaged materials.

3.10 SCHEDULE

- A. See contract drawings for floor finish plan and finish locations.

END OF SECTION

SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes modular, tufted carpet tile.

1.2 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation recommendations for each type of substrate.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
 - 1. Carpet Tile: Full-size Sample.
 - 2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch-long Samples.
- D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.
- E. Qualification Data: For Installer.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.
- G. Maintenance Data: For tile carpeting maintenance manuals to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS. Include the following:
 - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
 - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.
- H. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
- B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104, Section 5, "Storage and Handling."

1.5 PROJECT CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

1.6 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
 - 2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
 - 3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE - CPT-1

A. Products: Subject to compliance with requirements, provide the following:

1. Tarkett Tandus Centiva – Sentry #04930 modular carpet tile

a. Series: Flex-Aire Modular or ER3 Modular

b. Color: Provided manufacturer full range of colors for selection by Designer and Engineer.

2. “Or Equal” manufacturers will not be considered for this project.

3.

B. Construction: Level Loop

C. Face Weight: 14 oz/sq yd

D. Gauge: 1/13

E. Pile Characteristic: Tufted Textured Loop.

F. Pile Height Average: 0.117 inch

G. Pile Thickness: 0.084 inch

H. Density Factor: 6,0000 oz./cu. yd. minimum

I. Tuft Density: 115.2 tufts/sq in.

J. Fiber System: Antron Lumena Nylon

K. Dye Method: 100% Solution Dyed

L. Fluorine-Free Soil Penetration: Duratech

M. Primary Tufting Substrate: Synthetic Non-Woven

N. Size: 24 by 24 inches.

2.2 INSTALLATION TYPE

A. RS Adhesive System with full coverage peel & stick on carpet tile.

B. Wet Spread: Backing specific Tandus adhesive

C. Installation Method: Monolithic

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.

- B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
 - 1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
 - 2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
 - 3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch, unless more stringent requirements are required by manufacturer's written instructions.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.
- D. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: As recommended in writing by carpet tile manufacturer.
- C. Maintain dye lot integrity. Do not mix dye lots in same area.

- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders.
- H. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION

- A. Perform the following operations immediately after installing carpet tile:
 - 1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
 - 2. Remove yarns that protrude from carpet tile surface.
 - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protection of Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 096900 - ACCESS FLOORING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Access-flooring panels.
2. Understructure.
3. Floor panel coverings.
4. Continuous stainless steel grating panels in Vestibule G313, Engineering Room G305 and Office G307 along exterior wall.

Related Requirements:

5. Section 233600 "Air Terminal Units" for variable-air-volume diffusers.
6. Section 260526 "Grounding and Bonding for Electrical Systems" for connection to ground of access-flooring understructure.

1.2 COORDINATION DRAWINGS

- A. Coordinate location of mechanical, plumbing, electrical and cable tray work in underfloor cavity to prevent interference with access-flooring pedestals. The Contractor and each installer shall approve (sign-off on) the coordination drawings prior to their submission.
- B. Mark pedestal locations on subfloor using a grid to enable mechanical, plumbing, electrical and cable tray work to proceed without interfering with access-flooring pedestals.
- C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Raised Access Flooring installation indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 2. Structural attachments to existing concrete flooring.
 3. Size and location of Raised Access Flooring systems.
 - a. Indicated all solid panel locations
 - b. Indicated all perforated panel locations.
 - c. Indicated all raised floor system heights.
 - d. Indicated all raised floor system ramps.
 4. Penetrations of smoke barriers and fire-rated construction.
 5. Piping associated with HVAC, plumbing, and fire protection systems.
 6. Electrical conduits and cable trays.

1.3 PREINSTALLATION MEETINGS

- A. Conduct meeting at the project site in compliance with requirements of Form 817 Article 1.20-1.05.24 Subsection 2.
- B. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review connection with mechanical and electrical systems.
 - 2. Review requirements related to sealing the plenum.
 - 3. Review procedures for keeping underfloor space clean.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
- C. Shop Drawings: Include layout of access-flooring system and relationship to adjoining Work based on field-verified dimensions.
 - 1. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, and understructures.
- D. Samples for Verification: For the following products:
 - 1. Floor Covering: Full-size units.
 - 2. Exposed Metal Accessories: Approximately 10 inches in length.
 - 3. One complete full-size floor panel, pedestal, and understructure unit for each type of access-flooring system required.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of access-flooring system.
- C. Product Test Reports: For each type of flooring material and exposed finish, for tests performed by a qualified testing agency.
- D. Seismic Design Calculations: For seismic design of access-flooring systems including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Preconstruction Test Reports: For preconstruction adhesive field test.

1.6 SPARE PARTS:

- A. Furnish to the Engineer spare parts that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flooring Panels: 20% extra.
 - a. 10% extra for solid panels
 - b. 10% extra for perforated panels
 - 2. Pedestals: 10% extra.
 - 3. Stringers: 10% extra.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install access flooring until spaces have an ambient temperature between 50 and 90 deg F, and relative humidity is not less than 20 and not more than 70 percent.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Access flooring shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV.
 - a. Seismic Design Category. C.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second)(S_{DS}): 0.182.
 - 4. Design Spectral Response Acceleration at 1.0-Second Period S_{D1} : 0.064.
- C. Structural Performance: Provide access-flooring systems capable of complying with the following performance requirements according to testing procedures in CISCA's "Recommended Test Procedures for Access Floors":
 - 1. Concentrated Loads: 1500 lbf with the following deflection and permanent set:

- a. Top-Surface Deflection: 0.10 inch.
 - b. Permanent Set: 0.010 inch.
- 2. Ultimate Loads: 3000 lbf.
 - 3. Rolling Loads: With local or overall deformation not to exceed 0.040 inch.
 - a. Cisca Wheel 1: 10 passes at 1,250 lbf.
 - b. Cisca Wheel 2: 10,000 passes at 1,000 lbf.
 - 4. Stringer Load Test: 350 lbf at center of span with a permanent set not to exceed 0.010 inch.
 - 5. Pedestal Axial Load Test: 5000 lbf.
 - 6. Pedestal Overturning Moment Test: 1000 lbf x inches.
 - 7. Uniform Load Test: 300 lbf/sq. ft. with a maximum top-surface deflection not to exceed 0.040 inch and a permanent set not to exceed 0.010 inch.
 - 8. Drop Impact Load Test: 150 lb.

D. Fire Performance:

- 1. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25.
 - b. Smoke-Developed Index: 50 or less.
- 2. Combustion Characteristics: ASTM E 136.

E. Low-Emitting Materials: Flooring system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.2 MANUFACTURERS

- A. Source Limitations: Obtain access-flooring system from single source from single manufacturer.

2.3 FLOOR PANELS RFS-1A & RFS-1B

- A. Raised Floor System **RFS-1A & RFS-1B** (Utilized within all areas of the project minus the VDTR room): Subject to compliance with requirements, provide Concore 1500 Panels with Bolted Stringers as manufactured by Tate Access Floors, Inc, or comparable product by one of the following:
 - 1. ASM Modular Systems, Inc.
 - 2. Haworth Inc.

3. NetfloorUSA

- B. Floor Panels, General: Provide modular panels interchangeable with other field panels without disturbing adjacent panels or understructure.
1. Size: Nominal 24 by 24 inches.
 2. Height: **RFS-1A** 10" and **RFS-1B** 12" tall raised floor systems as indicated.
 3. Attachment to Understructure: Bolted.
- A. Cementitious-Core Steel Panels: Fabricated from cold-rolled steel sheet, with the die-cut flat top sheet and die-formed and stiffened bottom pan welded together, and with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish. Fully grout internal spaces of completed units with manufacturer's standard cementitious fill.
1. Solid Panels: Flat, solid surface on top and symmetrical crossing ribs on bottom; edge machined after casting to specified tolerances.
 2. Epoxy Finish: Conductive epoxy powder coating with a minimum average thickness of 2.5 mils and in color selected by designer from manufacturer's full range.
- B. Stringer Systems: Modular steel stringer systems designed to bolt to pedestal heads and form a grid pattern. Protect steel components with manufacturer's standard galvanized or corrosion-resistant paint finish.
1. Continuous Gaskets: At contact surfaces between panel and stringers to deaden sound, seal off the underfloor cavity from above, and maintain panel alignment and position.

2.4 FLOOR PANELS RFS-2

- A. Raised Floor System **RFS-2** (Utilized within the VDTR room only): Subject to compliance with requirements, provide Concore 1500 Panels with Bolted Stringers as manufactured by Tate Access Floors, Inc, or comparable product by one of the following:
1. ASM Modular Systems, Inc.
 2. Haworth Inc.
 3. NetfloorUSA
- B. Floor Panels, General: Provide modular panels interchangeable with other field panels without disturbing adjacent panels or understructure.
1. Size: Nominal 24 by 24 inches.
 2. Height: 15" tall raised floor systems as indicated.
 3. Attachment to Understructure: Bolted.
- C. Cementitious-Core Steel Panels: Fabricated from cold-rolled steel sheet, with the die-cut flat top sheet and die-formed and stiffened bottom pan welded together, and with

metal surfaces protected against corrosion by manufacturer's standard factory-applied finish. Fully grout internal spaces of completed units with manufacturer's standard cementitious fill.

1. Solid Panels: Flat, solid surface on top and symmetrical crossing ribs on bottom; edge machined after casting to specified tolerances.
2. Perforated Panels: Perforated top surface with holes of number, spacing, and size standard with manufacturer to produce a nominal open area of 25 percent. Provide mechanical dampers with each panel unit.
 - a. Quantity: As shown on Drawings.
 - b. Finish: Manufacturer's standard to match solid panels.
3. High Pressure Laminated Finish: Factory applied, NEMA LD 3, High-Wear type, Grade HDH fabricated in one piece to cover each panel face with integral trim edging.
 - a. Electrical Resistance: Average no less than 1 megohm and no more than 20,000 megohms when installed floor coverings are surface-to-ground tested according to NFPA 99.
 - b. Colors, Textures, and Patterns: As selected by designer from manufacturer's full range.

D. Stringer Systems: Modular steel stringer systems designed to bolt to pedestal heads and form a grid pattern. Protect steel components with manufacturer's standard galvanized or corrosion-resistant paint finish.

1. Continuous Gaskets: At contact surfaces between panel and stringers to deaden sound, seal off the underfloor cavity from above, and maintain panel alignment and position.

2.5 UNDERSTRUCTURE

A. Pedestals: Assembly consisting of base, column with provisions for height adjustment, and head (cap); made of steel.

1. Provide pedestals designed for use in seismic applications.
2. Base: Square or circular base with not less than 16 sq. in. of bearing area.
3. Column: Of height required to bring finished floor to elevations indicated. Weld to base plate.
4. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than 2 inches and for locking at a selected height, so deliberate action is required to change height setting and prevent vibratory displacement.
5. Head: Designed to support the panel system indicated.
 - a. Provide sound-deadening pads or gaskets at contact points between heads and panels.
 - b. Bolted Assemblies: Provide head with four holes aligned with holes in floor panels for bolting of panels to pedestals.

2.6 FABRICATION

- A. Fabrication Tolerances:
 - 1. Size: Plus or minus 0.020 inch of required size.
 - 2. Squareness: Plus or minus 0.015 inch, between diagonal measurements across top of panel.
 - 3. Flatness: Plus or minus 0.035 inch , measured on a diagonal on top of panel.
- B. Panel Markings: Clearly and permanently mark floor panels on their underside with panel type and concentrated-load rating.
- C. Bolted Panels: Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk screws with heads flush with top of panel.
 - 1. Captive Fasteners: Provide fasteners held captive to panels.
- D. Cutouts: Fabricate cutouts in floor panels for cable penetrations and service outlets. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with structural performance requirements.
 - 1. Number, Size, Shape, and Location: As indicated on drawings.
 - 2. Grommets: Where indicated, fit cutouts with manufacturer's standard grommets; or, if size of cutouts exceeds maximum grommet size available, trim edge of cutouts with manufacturer's standard plastic molding with tapered top flange.[Furnish removable covers for grommets.]
 - 3. Provide foam-rubber pads for sealing annular space formed in cutouts by cables.

2.7 ACCESSORIES

- A. Adhesives: Manufacturer's standard adhesive for bonding pedestal bases to subfloor.
 - 1. Adhesive shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Post-Installed Anchors: For anchoring pedestal bases to subfloor, provide two post-installed expansion anchors made from carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 (Mild), with the capability to sustain, without failure, a load equal to 1.5 times the loads imposed by pedestal overturning moment on fasteners, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

- C. Service Outlets: Standard UL-listed and -labeled assemblies, for recessed mounting flush with top of floor panels; for power, communication, and signal services; and complying with the following requirements:
1. Structural Performance: Cover capable of supporting a 1000-lbf concentrated load.
 2. Cover and Box Type: Hinged polycarbonate cover with opening for passage of cables when cover is closed and including frame and steel box or formed-steel plate for mounting electrical receptacles.
 3. Location: In center of panel quadrant unless otherwise indicated.
 4. Receptacles and Wiring: Electrical receptacles and wiring for service outlets are specified elsewhere.
 5. Receptacles and Wiring: Equip each service outlet with power receptacles to comply with the following requirements:
 - a. Type of Receptacle: Heavy-duty duplex, two-pole, three-wire grounding, 20 A, 125 V, NEMA WD 6, Configuration 5-20R unless otherwise indicated.
 - b. Number of Receptacles for Outlet: refer to electrical drawings for quantities.
 - c. Wiring Method: Factory wired for hardwiring in field with armored cable, containing three insulated No. 12 AWG solid-copper conductors, terminated with a 6-inch long pigtail.
 - d. Wiring Method: Power-in connectors, built into outlet housing, of type to fit power-in and power-out connectors of branch-circuit cables supplied with building electrical system.
- D. Plenum-Wall Brush Grommets: Self-sealing cable brush grommet with 4-by-13-inch rectangular usable area for passage of power and signal cables through plenum walls. Frame of aluminum with passageway consists of intermediate layer of flexible EPDM rubber and interwoven nylon filaments. Provide units with plastic cable tray for support of cables and protection of wallboard
- E. Cavity Dividers: Provide manufacturer's standard metal dividers located where indicated to divide underfloor cavities.
- F. Closures: Where underfloor cavity is not enclosed by abutting walls or other construction, provide metal-closure plates with manufacturer's standard finish.
- G. Ramps: Manufacturer's standard ramp construction of width and slope indicated, but not steeper than 1:12, with raised-disc or textured rubber or vinyl-tile floor coverings, and of same materials, performance, and construction requirements as access flooring.
- H. Panel Lifting Device: Panel manufacturer's standard portable lifting device for each type of panel required.

- I. Perimeter Support: Where indicated, provide manufacturer's standard method for supporting panel edge and forming transition between access flooring and adjoining floor coverings at same level as access flooring.

2.8 FLOOR GRILLE PANELS AND DAMPERS WITHIN **RFS-2**

- A. Provide in-floor cooling floor grille panels as indicated below.
 1. TATE GrateAire[®] die-cast aluminum panels or approved equal compatible with RFS-2 system.
 2. 56% open area; each grille shall be capable of providing 725 cfm.
 3. Provide high rolling load capacity (1000 lbs).
 4. Provide impact loading (100 lbs).
 5. Provide adjustable damper connection below grille.
 6. Anti-static Sparklite White powder coat finish or approved equal - 25,000 TO 20,000,000,000 ohms when tested at 500 volts per NFPA 99 .
 7. Panel height at comer: 1.250". Total panel height 1.687".
 8. Flange width with tabs: .480" to accommodate 3/4" wide stringers.
 9. Panel weight: 4.7 lb./f
 10. Non-combustible material.
 11. Class A flame spread rating.
- B. Provide in-floor cooling floor manual dampers as indicated below.
 1. TATE Opposed Blade Damper (ODB) panels or approved equal compatible with RFS-2 system.
 2. Provide adjustability through the top surface of the panel without the removal of the in-floor grille for balancing airflow to equipment.
 3. Provide quarter turn damper adjustment for 0-100% range
 4. Field-mounted dampers attached to the bottom of the in-floor grille.
 5. Field-mounted using self-tapping screws.
 6. Provide side baffles.
 7. Clear anodized extruded aluminum.
 8. Damper Weight: 3.8 lbs.
 9. Dimensions: 22.5" length x 22.5" width x 1.75" depth

2.9 CONTINUOUS STAINLESS STEEL GRATING PANELS

- A. Provide McNICHOLS[®] Close Mesh GCM Series Gratings, GCM-1 or approval equal as indicated below.
 1. Close Mesh Bar Grating formed by a pressure locked process where the cross bars and rectangular bearing bars are forced together using tremendous hydraulic pressure. The result is a flush top, durable grating that provides excellent lateral support and a small open space between the bearing bars.
 2. Material: 304 Stainless Steel
 3. Center to Center Bearing Bar Spacing: Maximum 7/16 inch on center bar spacing to provide ADA compliance.
 4. Center to Center Cross Bar Spacing: 4" on center
 5. Surface: Smooth

6. Banding: Provide Trim Banding on all sides, - The metal bar is welded only at every 4th to 6th bearing bar.
7. Bearing Bar Height: 1 1/2"
8. Bearing Bar Thickness: Close Mesh grating is 3/16 inch.
9. Span: 1'-0" maximum.
10. Traffic type: pedestrian type
11. Width: Cut to size as indicated on the drawings.
12. Length: Cut to size as indicated on the drawings.
13. Anchors: Provide four anchor blocks for each full panel in each of the corners – ADA spacing requirement compliance, the lug or anchor will typically be attached at the top of the grating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer and manufacturer's representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 1. Verify that substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, foreign deposits, and debris that might interfere with attachment of pedestals.
 2. Verify that concrete floor sealer and finish have been applied and cured.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Lay out floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches.
- B. Locate each pedestal, complete any necessary subfloor preparation, and vacuum subfloor to remove dust, dirt, and construction debris before beginning installation.

3.3 INSTALLATION

- A. Install access-flooring system and accessories under supervision of access-flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.
- B. Adhesive Attachment of Pedestals: Set pedestals in adhesive, according to access-flooring manufacturer's written instructions, to provide full bearing of pedestal base on subfloor.

- C. Mechanical Attachment of Pedestals: Attach pedestals to subfloor with post-installed mechanical anchors.
- D. Adjust pedestals to permit top of installed panels to be set flat, level, and to proper height.
- E. Stringer Systems: Secure stringers to pedestal heads according to access-flooring manufacturer's written instructions.
- F. Install flooring panels securely in place, properly seated with panel edges flush. Do not force panels into place.
- G. Scribe perimeter panels to provide a close fit with adjoining construction with no voids greater than 1/8 inch where panels abut vertical surfaces.
 - 1. To prevent dusting, seal cut edges of steel-encapsulated, wood-core panels with sealer recommended in writing by panel manufacturer.
- H. Cut and trim access flooring and perform other dirt-or-debris-producing activities at a remote location or as required to prevent contamination of subfloor under already-installed access flooring.
- I. Grounded Flooring Access Panel Systems: Ground flooring system as recommended by manufacturer and as needed to comply with performance requirements for electrical resistance of floor coverings.
 - 1. Panel-to-Understructure Resistance: Not more than 10 ohms as measured without floor coverings.
- J. Underfloor Dividers: Scribe and install underfloor-cavity dividers to closely fit against subfloor surfaces, and seal with mastic.
- K. Closures: Scribe closures to closely fit against subfloor and adjacent finished-floor surfaces. Set in mastic and seal to maintain plenum effect within underfloor cavity.
- L. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area as installation of floor panels proceeds.
- M. Seal underfloor air cavities at construction seams, penetrations, and perimeter to control air leakage, according to manufacturer's written instructions.
- N. Install access flooring without change in elevation between adjacent panels and within the following tolerances:
 - 1. Plus or minus 1/8 inch from a level plane over entire access-flooring area.

3.4 PROTECTION

- A. Prohibit traffic on access flooring for 24 hours and removal of floor panels for 72 hours after installation to allow pedestal adhesive to set.
- B. After completing installation, vacuum access flooring and cover with continuous sheets of reinforced paper or plastic. Maintain protective covering until time of Substantial Completion.
- C. Replace access-flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.

END OF SECTION 096900

SECTION 099123- PAINTING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Surface preparation and the application of paint systems on the following interior and exterior substrates:
 - 1. Galvanized metal.
 - 2. Gypsum Board.

1.3 REFERENCE STANDARDS

- A. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; current edition, www.paintinfo.com.
- B. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Master Painters and Decorators Association; 2004.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
- C. Verification Samples: Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded. Submit on gypsum board with cut edges taped, 12 x 12 inch in size.
 - 1. Submit textured coatings if required to match existing surfaces.
- D. Transparent Finish Samples: Submit two samples, illustrating selected colors and specular gloss for each color and system selected with specified coats cascaded. Submit on species and quality of wood on which finish will be applied, 12 x 12 inch in size.
- E. Resubmit samples until required color, specular gloss, and texture are achieved.
- F. Quality Assurance Submittals:
 - 1. Certification of Compliance with V.O.C. Regulations: Submit Certification by manufacturer that products supplied comply with Regulations controlling use of volatile organic compounds (VOCs).

2. Qualification Data: Submit Applicator's data demonstrating experience and certifying approval of manufacturer.
3. Manufacturer's Instructions: Indicate special surface preparation procedures.

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. Deliver all painting materials in sealed, original labeled containers bearing manufacturer's name, brand name, type of paint or coating and color designation, standard compliance, materials content as well as mixing and/or reducing and application requirements.
- B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.
- C. Where toxic and/or volatile / explosive / flammable materials are being used, provide adequate fireproof storage lockers and take all necessary precautions and post adequate warnings (e.g. no smoking) as required.
- D. Take all necessary precautionary and safety measures to prevent fire hazards and spontaneous combustion and to protect the environment from hazard spills. Materials that constitute a fire hazard (paints, solvents, drop clothes, etc.) shall be stored in suitable closed and rated containers and removed from the site on a daily basis.

1.7 PROJECT CONDITIONS

- A. Environmental Conditions: Comply with following minimum temperature requirement, unless otherwise recommended by paint manufacturer. Provide continuous heating and ventilation as required to maintain surface and ambient temperatures as noted below for at least 24 hours before, during and for at least 48 hours after paint application.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 Degrees F. Maintain storage containers in a clean condition, free of foreign materials and residue.

- C. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 Degrees F unless otherwise indicated in writing by manufacturer.
- D. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 Degrees F unless otherwise indicated in writing by manufacturer.
- E. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 Degrees F above the dew point; or to damp or wet surfaces.
- F. Lighting: Provide minimum 80 foot candle light level at mid-height of substrate surface.

1.8 SPARE PARTS

- A. Furnish spare parts to the Engineer from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents.
 - 1. Label each container with color and type in addition to manufacturer's label.
 - 2. Quantity: 5 percent, but not less than 1 gallon or 1 case, as appropriate, 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. Benjamin Moore & Co.
 - 2. MAB Paints
 - 3. Sherwin-Williams Company (The)..

2.2 PAINT, GENERAL

- A. Paints and Coatings: Paints and coatings are certified for low VOCs by the California Department of Health Services "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers," include 2004 Addenda or are certified as low VOC by one of the following:
 - 1. Scientific Certification Systems – Indoor Advantage-Gold
 - 2. GREENGUARD Certification Program
 - 3. Green Seal GS-11 (paints and coatings)
- B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

C. Colors: See Finish Schedule.

2.3 SCHEDULE OF RAILING FINISHES

- A. Galvanized Metal (Including Interior and Exterior Handrails and Railings):

Semi Gloss Finish

Prime Coat: Benjamin Moore IMC Acrylic Metal Primer (M04)

Finish: Two (2) coats Benjamin Moore IMC Direct to Metal Acrylic Semi Gloss (M29)

2.4 SCHEDULE OF INTERIOR FINISHES

- A. Gypsum Wallboard Walls:

Semi-Gloss Finish

Prime Coat: Primer, latex, interior, MPI #149 X-Green: S-W ProMar 200 Zero VOC Latex Primer, B28W2600, at 4.0 mils wet, 1.5 mils dry.

Intermediate Coat: Latex, interior, matching finish.

Finish: Latex, interior, semi-gloss, Gloss Level 4, MPI #43 X-Green: S-W ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series, at 4.0 mils wet, 1.6 mils dry, per coat.

- B. Ferrous Metal (Including Steel Doors and Steel Frames):

Semi-Gloss Finish

Prime Coat: Primer, rust-inhibitive, water based, MPI #107: S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, at 5.0 to 10 mils wet, 2.0 to 4.0 mils dry.

Intermediate Coat: Water-based acrylic, interior, matching finish.

Finish: Water-based acrylic, semi-gloss, Gloss Level 5, MPI #147 X-Green: S-W Pro Industrial Acrylic Semi-Gloss Coating, B66-650 Series, at 2.5 to 4.0 mils dry, per coat.

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. 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 and paint systems 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 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.
- E. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.

- 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. 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.

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 items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
- 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 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 the Engineer, and leave in an undamaged condition.

- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

END OF SECTION

SECTION 101010 - VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Stationary Markerboards and Tackboard Assemblies, for the following:
 - a. Markerboards.
 - b. Vinyl-Covered Tackboards.
 - c. Aluminum Trim with Integral Map Rail and Hooks.
- B. Referenced Standards:
 - 1. American Society for Testing Materials:
 - a. ASTM-E 84 Standard Test Method for Surface Burning Characteristics for Building Materials.
 - b. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded bars, Rods, Wires, Profiles and Tubes.
 - 2. S-104 Performance Specification for Porcelain Enamel Markerboards and Chalkboards

1.2 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Submit manufacturer's printed product literature describing tackboards, metal trim, and accessories, including restrictions on markers. For each type of product indicated.
- C. Product test reports for surface-burning characteristics of vinyl fabrics.
- D. Warranty.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative of manufacturer for installation and maintenance of units required for this Project.
- B. Manufacturer: All markerboards and tackboards and associated hardware are furnished by single manufacturer for entire project, unless otherwise acceptable to Designer.
- C. Fire-Test-Response Characteristics: Provide fabrics with the surface-burning characteristics indicated, as determined by testing identical products per ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having

jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-built visual display boards, including factory-applied trim, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Designer. When overall dimensions require delivery in separate units, pre-fit components at the factory, disassemble for delivery, and make final joints at the site. Use concealed mechanical joint to maintain alignment in field.
- B. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- C. Storage and Protection: Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.
- D. After opening and inspecting boards for damage, return them to their original crates or cartons for storage and do not uncrate until boards are to be installed.
- E. When uncrated, do not allow boards to lean at an angle against a wall or other objects, or to lie on the floor for any length of time.
- F. Store boards in as close to a vertical position as possible.

1.5 PROJECT CONDITIONS

- A. Environmental Requirements: Comply with manufacturer's recommendations for stabilizing area to the approximate normal occupied conditions of interior temperature and humidity.
- B. Verify actual dimensions by field measurement before fabrication; show recorded measurements on shop drawings.
- C. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

1.6 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Most manufacturers' warranties only include replacement of material; labor for removal and reinstallation is excluded.

- C. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces become slick or shiny.
 - c. Surfaces exhibit crazing, cracking, or flaking.
 - 2. Warranty Period: 50 years from date of Substantial Completion.
 - 3. If you use Claridge LCSII, which is a white low gloss surface, it carries a "lifetime of the building" warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. As a basis of design, details and specifications based on specified products by Claridge Products and Equipment, Inc., Harrison, Arkansas – "Series 3" Stationary Tackboard Assemblies.
 - 1. Manufacturer's offering products similar to specified products include:
 - a. Marsh Industries, Inc, Philadelphia, Ohio – Contractor Series Boards.
 - b. Polyvision Corporation, Norcross, Georgia - 500 Series.
 - c. Or Approved Equal.

2.2 BOARD UNIT ASSEMBLIES

- A. Markerboard Units **MB-1**:
 - 1. Liquid Chalk Porcelain Enamel Steel Chalkboards: Similar to " LCS-II Porcelain Enamel Steel Chalkboards" by Claridge Products and Equipment, Inc or approved equal.
 - a. The surface of the cold rolled steel, specially processed for temperatures used in coating porcelain on steel, is pre-cleaned to ensure bond between the steel and the porcelain surface. After pre-cleaning, during a 3-coat process, both steel surfaces receive a ground coat of porcelain enamel. Then, a color cover coat of porcelain is applied to one surface of the ground coat and is fusion bonded to the steel substrate at a temperature necessary to reduce steel and porcelain stresses, but no less than 1200 degrees F. LCS-II, with low gloss, can be used as a projection surface.
 - b. Smooth, low-gloss, dry-erase porcelain surface for easy writing, clean erasing, and projecting.
 - c. Face Sheet: Min. 24 gauge steel with porcelain enamel finish suitable for use with liquid chalk markers similar to "LCS-II Liquid Chalk Writing System" by Claridge Products and Equipment Inc.
 - d. Core Material: Min. 7/16-inch MDF by Claridge Products and Equipment Inc.
 - e. Backing: Min. 0.015-inch aluminum sheet / moisture barrier backing.
 - f. Size: As indicated on the drawings.

- B. Tackboards **TB-1**: Similar to "Fabricork Vinyl Bulletin Boards" by Claridge Products and Equipment Inc. or approved equal.
 - 1. Face Material: Type II vinyl with cork core material and particleboard backing similar to "Duracore". Color and pattern as selected by Designer from manufacturer's full range of colors and patterns.
 - 2. Flammability of Vinyl and Cork Materials (ASTM E-84) - Meet or exceed following requirements:
 - a. Flame Spread Less Than 25
 - b. Smoke Developed Less Than 450
 - 3. Assembly Weight: 1 lb. /sq. ft.
 - 4. Assembly Thickness: Approximately 1/2-inch.
 - 5. Tackboard vinyl weight: min. 20 oz.
 - 6. Size: As indicate on the drawings.

- C. Trim and Accessories:
 - 1. Trim: 1 1/4-inch aluminum perimeter trim, mitered corners, concealed fasteners with built-in concealed hangers, min. 2-inch angles; similar to Claridge Products and Equipment Inc. or approved equal.
 - 2. Integral Map Rail: Provide head trim on tack board assemblies with integral 2-inch wide map rail similar to "Hang Tight Rail System" by Claridge Product and Equipment Inc. or approved equal.
 - a. Include min. (2) metal display hooks per 4 ft. of map rail, similar to "No. 76M Spring Clip Map Hook" by Claridge Product and Equipment Inc.
 - b. Include min. (1) metal flag holder per room, similar to "No. 76FHFlag Holders" by Claridge Product and Equipment Inc.
 - c. Map rail to run full length of board width.
 - 3. Trim and Accessory Finish: Satin anodized aluminum or as selected by Designer from full range of colors and finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which tackboards are to be installed in coordination with Installer of materials and components specified in this Section and notify affected Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION

- A. Deliver factory-built tack board units completely assembled in one piece without joints, where possible. Where dimensions exceed panel size, provide 2 or more pieces of equal

length, as acceptable to Designer. When overall dimensions require delivery in separate units, pre-fit at factory, disassemble for delivery, and make final joint at site.

1. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Designer.
2. Provide mullion-type trim at joints between markerboard and tackboard.
3. Provide manufacturer's recommended divider bar for vertical joints in markerboard and tackboard.

B. Install markerboard and tackboard assemblies in locations shown on Drawings in accordance with manufacturer's instructions. Provide all grounds, clips, backing materials, brackets, and anchors, trim and accessories for complete installation.

C. Do not install boards on damp walls or in damp and humid weather without heat in the building.

D. Install level and plumb, keeping perimeter trim straight in accordance with manufacturer's recommendations.

E. Fastening with Clips and Adhesive:

1. L-Clip Installation – Use manufacturer recommended “L” shaped aluminum clips to match the frame of the board. Space clips @ 24” on center max at the top and bottom of the board.
 - a. In addition to the “L” clips provide adhesive installation at the marker boards and tackable boards. Utilize a quality construction adhesive (marker boards and tackable units) to ensure the integrity of the installation. Apply Two (2) golf ball size spots evenly spaced in height at 48” o.c. on the back of the board surface.
 - b. Provide adhesive to prevent a "hollow" effect and "cupping" of boards when mounted to wall.

F. Verify that accessories are installed as required for each unit.

3.3 CLEANING

A. Remove temporary coverings and protection of adjacent work areas.

B. Repair or replace damaged installed products.

C. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance.

D. Remove construction debris from project site and legally dispose of debris.

E. At completion of work, clean surfaces and trim in accordance with manufacturer's recommendations, leaving all materials ready for use.

F. Comply with waste management and recycling program requirements.

3.4 PROTECTION

- A. Protect installed product and finish surfaces from damage during construction.

END OF SECTION

SECTION 101400 – SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:

1. Interior panel signs.

1.2 DEFINITIONS

- A. ADA-ADA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Submit manufacturer's product literature, technical data and installation instructions for each type of sign required, including construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of sign, for each product indicated.
- C. Shop Drawings: Submit shop drawings for fabrication and erection of interior signs, including plans, elevations, and large-scale sections of typical members and other components. Show mounting methods, grounds, mounting heights, layout, spacing, reinforcement, accessories, and installation details. Include plans, elevations, sections, details, and attachments to other Work.
1. Provide message list for each sign, including large-scale details of wording, lettering, artwork, and Braille layout. Photocopies of Design documentation not acceptable.
2. Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
3. Provide message list for each sign, including large-scale details of wording, lettering, artwork, and Braille layout.
- D. Samples: For each sign material indicated that involves color selection.
1. Initial Selection: Submit samples of each color and finish of exposed materials and accessories for interior signs demonstrating manufacturer's full range of colors and finishes for selection by Designer.
2. Approved samples will not be returned for installation into Project.

1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
- B. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.
- C. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines, and ICC/ANSI A117.1.

1.5 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Manufacturer's standard form in which manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of embedded graphic image colors and sign lamination.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fiberglass Sheet: Molded, seamless, thermosetting, glass-fiber-reinforced polyester panels that shall match the existing signage with a minimum tensile strength of 15,000 psi (103 MPa) when tested according to ASTM D 638 and with a minimum flexural strength of 30,000 psi (207 MPa) when tested according to ASTM D 790.
- B. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
- C. Polycarbonate Sheet: Of thickness indicated, manufactured by extrusion process, coated on both surfaces with abrasion-resistant coating:
 - 1. Impact Resistance: 16 ft-lbf/in. (854 J/m) per ASTM D 256, Method A.
 - 2. Tensile Strength: 9000 lbf/sq. in. (62 MPa) per ASTM D 638.
 - 3. Flexural Modulus of Elasticity: 340,000 lbf/sq. in. (2345 MPa) per ASTM D 790.
 - 4. Heat Deflection: 265 deg F (129 deg C) at 264 lbf/sq. in. (1.82 MPa) per ASTM D 648.

5. Abrasion Resistance: 1.5 percent maximum haze increase for 100 revolutions of a Taber abraser with a load of 500 g per ASTM D 1044.

2.2 PANEL SIGNS

- 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. ASI-Modulex, Inc.
 2. Grimco, Inc.
 3. Matthews International Corporation; Bronze Division.
 4. Mills Manufacturing Company.
- B. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner, complying with the following requirements:
 1. Acrylic Sheet: 0.060 inch (1.52 mm) thick.
 2. Edge Condition: Square cut.
 3. Corner Condition: Square cut.
 4. Mounting: Unframed.
 - a. Wall mounted with two-face tape.
 - b. Manufacturer's standard anchors for substrates encountered.
 5. Custom Paint Colors: Match Pantone color matching system.
 6. Color: One tone color to match existing signage color as indicated in drawings and selected by Designer from manufacturer's full range.
 7. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch (0.8 mm) above surface with contrasting colors.
- C. Tactile and Braille Sign: Manufacturer's standard process for producing text and symbols complying with ADA-ABA Accessibility Guidelines and with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 Braille. Produce precisely formed characters with square-cut edges free from burrs and cut marks; Braille dots with domed or rounded shape.
 1. Panel Material: Opaque acrylic sheet.
 2. Raised-Copy Thickness: Not less than 1/32 inch (0.8 mm).
- D. Engraved Copy: Machine engrave letters, numbers, symbols, and other graphic devices into panel sign on face indicated to produce precisely formed copy, incised to uniform depth.
 1. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.

- 2. Engraved Opaque Acrylic Sheet: Fill engraved copy with enamel.
- E. Subsurface Copy: Apply minimum 4-mil- (0.10-mm-) thick vinyl copy to back face of clear acrylic sheet forming panel face to produce precisely formed opaque image. Image shall be free of rough edges.
- F. Colored Coatings for Acrylic Sheet: For copy and colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are UV and water resistant for years for application intended.
 - 1. Color: As selected by Designer from manufacturer's full range.
- G. Panel Sign Schedule: Listed at the end of this specification section.

2.3 INTERIOR SIGN TYPES

- A. Interior Signage Types: Refer to the drawings for locations and quantities of the signage within the building and graphical representation of the signage types indicated below. Adjust signage size as required for content and to meet code requirements.
 - 1. **Type 1:** Room Name/Number Sign: Minimum 2 1/2" x 10" sign with square edge. Sign to match existing room signage within the building
 - a. Text: All room numbers printed in 1" bold high Helvetica medium lettering and two lines, where needed. All room names printed in 5/8" high Helvetica medium lettering.
 - b. Included tactile and braille as required and indicated.
 - 2. **Type 2:** Unisex Restroom Sign: Minimum 11" x 8" sign with beveled edge.
 - a. Graphics: Male/ Female symbol and CT wheelchair accessibility symbol, if applicable and as indicated in contract drawings.
 - b. Text: Printed in 1" high Helvetica medium lettering.
 - c. Included tactile and braille as required and indicated.
 - 3. **Type 3:** 1 Hour Rating Sign
 - A. Minimum 0.5 inch lettering.
 - b. Graphics: As indicated in contract drawings.
 - c. Text: " 1 HR RATED FIRE/SMOKE WALL – PROTECT ALL OPENINGS AND PENETRATIONS"
 - d. Aluminum 10" x 14" 40 mil thick
 - e. Attachment: Engineer Grade Adhesive
 - f. Locate above ceilings at locations indicated in the plans. Shall be provided on each side of the walls indicated.

2.4 FABRICATION

- A. General: Provide manufacturer's standard signs of configurations indicated.
 - 1. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous.

2.5 ACRYLIC SHEET FINISHES

- A. Colored Coatings for Acrylic Sheet: For copy and background and frame colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions (by Installer): Examine conditions under which signage is to be installed and notify Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in manner acceptable to Installer.
- B. Verify that items, including anchor inserts provided under other sections of Work are sized and located to accommodate relevant signs.

3.2 INSTALLATION

- A. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
 - 1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Interior Wall Signs: Install signs on walls adjacent to latch side of door where applicable. Where not indicated or possible, such as double doors, install signs on nearest adjacent walls. Locate to allow approach within 3 inches (75 mm) of sign without encountering protruding objects or standing within swing of door.
 - 3. Coordinate final placement of final locations for all signage based on final built wall configurations.

3.1 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.
- B. Dispose of waste legally and in accordance with local jurisdiction requirements.
- C. Comply with waste management and recycling program requirements.

END OF SECTION

SECTION 102600 – WOOD WALL PANELING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Wall guards.
2. Wood wall coverings.

1.2 SUBMITTALS

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
2. Include fire ratings of units recessed in fire-rated walls and listings for door-protection items attached to fire-rated doors.

C. Shop Drawings: For each type of wall and door protection showing locations and extent.

1. Include plans, elevations, sections, attachment details and relationship to other adjacent materials.

D. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:

1. Corner Guards: 12 inches long. Include example top caps.
2. Abuse-Resistant Wall Covering: 6 by 6 inches square.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of corner guard.

B. Sample Warranty: For special warranty.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 - 1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
 - 2. Keep plastic materials out of direct sunlight.
 - 3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.
 - a. Store corner-guard covers in a vertical position.

1.5 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Special Warranty: Manufacturer agrees to repair or replace components of wall-and door-protection units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
 - b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.
 - 2. Warranty Period: Five years from date of Substantial Completion.

1.6 SPARE PARTS

- A. Furnish complete touchup kit for each type of wood wall coverings provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged casework finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall- and door-protection products of each type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

2.3 CORNER GUARDS

- A. Surface-Mounted, Metal Corner Guards **CG-1**: Fabricated as one piece from formed or extruded metal with formed edges; with 90 degree turn to match wall condition.
1. Acrovyn Corner Guard - Renaissance Corner Guards by Construction Specialties: Stainless Steel Corner Guards ACO-8 or approved equal.
 2. Material: Extruded aluminum, minimum 0.0625 inch thick, with powder coated black finish.
 - a. Aluminum: To be alloy 5005 H34 with powder coated finish for model ASCO-8; minimum strength and durability properties as specified in ASTM B221.
 - b. Thickness: Minimum 0.0500 inch.
 - c. Finish: Directional satin, No. 4
 3. Wing Size: Nominal 3-1/2 by 3-1/2 inches.
 4. Corner Radius: 3/16 inch.
 5. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes.

2.4 WOOD WALL PANELS

- A. Wood wall panel coverings **WWP-1**: Fabricated from 1/32" thick wood veneer factory bonded to face side of a particle board core with a factory finish material.
1. Acrovyn Wall Panel - Renaissance wood wall panel by Construction Specialties: or approved equal.
 2. Size: 48 by 120 inches.
 3. Material: Renaissance wood panel 3/8" thickness with standard square veneer edges and square lumber edges.
 4. Sheet Thickness: 3/8" thickness
 5. Color and Texture: Mahogany to match existing building and as selected by Designer from manufacturer's full range.
 6. Height: Full wall.

7. Reveals: 1 ½" wide Acroyn reveal strips with Gold finish.
8. Trim and Joint Moldings: Extruded rigid plastic that matches wall-covering color.
9. Mounting: Demountable Z-clip: to be 2" wide aluminum panel clips used in conjunction with continuous aluminum wall extrusions.

2.5 MATERIALS

- A. Particleboard and Medium-Density Fiberboard: Manufacturer's standard.
- B. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

2.6 FABRICATION

- A. Fabricate wall panels according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.7 FINISHES

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 - 1. For wall and door protection attached with adhesive, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings.
- C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.
 - 1. Provide anchoring devices and suitable locations to withstand imposed loads.
- D. Wall Panels: Install top and edge moldings, corners, and divider bars as required for a complete installation.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

SECTION 102800 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Toilet Accessories.
 - 2. Wall Mirrors.

1.2 REFERENCES STANDARDS

- A. ASTM A 167 – Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip; 1999 (Reapproved 2004).
- B. ASTM A 666 – Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar; 2003.
- C. ASTM C 1036 – Standard Specification for Flat Glass; 2006
- D. GSA CID A-A-3002 – Mirrors, Glass; U.S. General Services Administration; 1996.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
- C. Barrier Free Compliance: Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines, and ICC/ANSI A117.1.
- D. Product Schedule:
 - 1. Identify locations using room designations indicated on plans.
 - 2. Identify products using designations indicated on plans and in the schedule.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the Americans with Disabilities Act (ADA) and with code provisions as adopted by authorities having jurisdiction.

- B. Electrical Components, Devices and Accessories: Listed and labeled by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
- C. Qualifications:
 - 1. Manufacturer: Obtain each product type and all associated accessories through one source from single manufacturer.
 - 2. Installer: Workers to be approved by manufacturer and supply list of recently completed installations. Within the past (5) years with contract information of owner project location/description.

1.5 PROJECT/SITE CONDITIONS

- A. Field Measurements: Where dimensions of surfaces on which they are installed determine sizes of products, verify dimensions by field measurement before fabrication and indicate measurements on Shop Drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection: Provide secure location for accessories delivered to Project.

1.7 SEQUENCING AND SCHEDULING

- A. Schedule delivery and installation of items to avoid delay of Project.
- B. Coordination:
 - 1. Coordinate with steel stud and carpentry work to provide suitable back up to support units attached to stud walls.
 - 2. Coordinate with supplier of metal toilet partitions to obtain suitable reinforcement properly located to receive grab bars in handicap stalls.

PART 2 - PRODUCTS

2.1 TOILET ROOM ACCESSORIES

- 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. A & J Washroom Accessories, Inc.
 - 2. American Specialties, Inc.

3. Bobrick Washroom Equipment, Inc.
4. Bradley Corporation.
5. Kimberly-Clark Professional.

B. Toilet Tissue (Roll) Dispenser : (**TD**)

1. Mounting: Surface mounted.
2. Operation: Eccentric-shaped, molded-plastic spindle; core cannot be removed until roll is empty.
3. Capacity: Designed to hold one full 12-inch diameter jumbo senior tissue roll and one roll stub. Toilet tissue used is Scott 07202.
4. Material and Finish: ABS plastic, gray.

C. Soap Dispenser: (**SD**)

1. Description: Designed for dispensing soap in liquid or lotion form.
2. Mounting: Horizontally oriented, surface mounted.
3. Capacity: 40-oz.
4. Materials: Stainless steel piston, springs, and internal parts designed to dispense soap in measured quantity by pump action. Provide cover of type 304 stainless steel in satin finish.
5. Lockset: Tumbler type.
6. Refill Indicator: Window type.

D. Sanitary Napkin Dispenser: (**ND**)

1. Type: Sanitary napkin and tampon.
2. Mounting: Surface mounted.
3. Capacity: Minimum 15 napkins and 20 tampons.
4. Operation: Single coin (25 cents).
5. Exposed Material and Finish: Stainless steel, No. 4 finish (satin)
6. Lockset: Tumbler type with separate lock and key for coin box.

E. Grab Bar : (**GB1, GB2 and GB3**)

1. Mounting: Flanges with concealed fasteners.
2. Material: Stainless steel, 0.05 inch thick.
 - a. Finish: Smooth, No. 4, satin finish on ends and slip-resistant texture in grip area.
3. Outside Diameter: 1-1/2 inches.
4. Configuration and Length: 18", 36" and 42" as indicated on the plans.
5. Bar mounting shall have minimum 300-lb. load capacity.

F. Waste Receptacle: **(WR)**

1. Basis-of-Design Product: Bobrick Washroom Equipment Mod. # B-3644.
2. Mounting: Recessed
3. Capacity: 12-gallon waste area.
4. Material and Finish: Stainless steel, 18-85, Type 304, No. 4 finish (satin).

G. Paper Towel Dispenser: **(PT)**

1. Mounting: Surface mounted, concealed fasteners.
2. Minimum Capacity: 8-inch wide, 800-foot long roll.
3. Material and Finish: Plastic Translucent Smoke.

H. Mirror: **(M)**

1. Frame: Stainless-steel angle, 0.05 inch thick, Stainless steel, fixed.
 - a. Corners: Manufacturer's standard.
2. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
 - a. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.
3. Size: 18" x 30" as indicated on the plans.

I. Hand Dryer: **(HD)**

1. Basis-of-Design Product: TrimLine ADA No-Touch Surface Mount Hand Dryer, Mod. # B-7120.
2. Mounting: Surface mounted, concealed fasteners.
3. Material and Finish: 22-gauge, zinc-plated steel with white epoxy cover with black plastic trim, automatic operation, dual air outlets.

J. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which toilet and bath accessories are to be installed in coordination with Installer of materials and components specified in this Section and notify Contractor, of any conditions detrimental to proper and timely

installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Mounting Heights and Locations: As required by accessibility regulations, as indicated on drawings and as follows:
 - 1. Bottom of Mirrors: See plans.
 - 2. Grab Bars at Barrier-Free Stalls: See plans.
- D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- E. Toilet and Bathroom Accessory Installation: Install concealed mounting devices and fasteners fabricated of same material as accessories or of galvanized steel. Install exposed mounting devices and fasteners finished to match accessories. Provide theft-resistant fasteners for all accessory mountings. Secure toilet room accessories and related items to adjacent walls and partitions complying with the manufacturer's instructions for each item and for each type of substrate construction.
- F. Wall Mirror Installation: Secure mirrors to walls in concealed "tamperproof" manner with special hangers, toggle bolts, or screws. Set unit straight and square at locations and mountings shown in accordance with manufacturer's instructions.
- G. Provide solid substrate of fire retardant treated wood blocking to properly support all accessories in framed construction.
- H. Report any conflicts in layout prior to installation of any devices.
- I. Coordinate installation of all devices with plumbing devices and electrical devices to avoid conflicts. Report any conflicts prior to installation.

3.2 ADJUSTING/CLEANING

- A. Lubricate bearings and sliding parts; adjust to ensure smooth, easy operation.
- B. Clean all device surfaces and clean adjacent surfaces soiled by device installation. Avoid use of abrasive cleaners or solutions containing corrosive solvents. Use cleaning materials recommended by manufacturer.

END OF SECTION

SECTION 104400 - FIRE-PROTECTION CABINETS AND EXTINGUISHER

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes but is not limited to the following:
 - 1. Portable pressurized fire extinguishers including, but not limited to:
 - a. Multi-Purpose Dry Chemical Extinguisher
 - 2. Fire-protection cabinets.

1.2 REFERENCE STANDARDS

- A. NFPA 10 – Standard for Portable Fire Extinguishers; National Fire Protection Association; 2007.
- B. UL (FPED) – Fire Protection Equipment Directory; Underwriters Laboratories Inc., current edition.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Submit manufacturer's product literature, technical specifications, application instructions, product storage and handling requirements, and similar data for each product specified below as required to demonstrate compliance with specified requirements and provide complete application information.
- C. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
 - 1. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
 - 2. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.
- D. Field Conditions
 - 1. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.
- E. Samples: For each exposed cabinet finish.

1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
- C. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Apply vinyl lettering on field-painted fire-protection cabinets after painting is complete.

1.6 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: (6) Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. As a basis of Design, details and specifications have been based on:
 - 1. Croker Corporation; Elmsford, New York
- B. Other products that may be acceptable after a compliance review include:
 - 1. Strike First Corporation of America, www.strikefirstusa.com; Front Royal, Virginia
 - 2. JL Industries, Inc.; www.jlindustries.com
 - 3. Larsen's Manufacturing Co; www.larsensmfg.com
 - 4. Potter-Roemer, www.potterroemer.com
 - 5. Or Approved Equal.

2.2 FIRE EXTINGUISHER CABINETS AND COMPONENTS

- A. Type "A" Semi-Recessed Fire Extinguisher Cabinets (**FEC**) – Non Rated; or provide rated cabinets where FEC shown in rated wall.

1. Semi - Recessed type stainless steel construction, Type #4 finish with 16 gauge steel tub; similar to "No. 1621-SS with Full Panel Door Style" by Croker or approved equal with following features:
 - a. Stainless Steel #4 Finish and white enamel finish on interior.
 - b. Door with tempered safety glass meeting ANSI Z97.1-84 standards, primed-finish, and continuous hinge with brass pin.
 - c. Rigid tubular construction door and frame with all joints welded and ground smooth and attached to cabinet tub with adjustable screws.
 - d. Nominal inside dimensions - 12 inches wide x 27 inches high x 7-3/4 inches deep.

2.3 PORTABLE PRESSURIZED FIRE EXTINGUISHERS AND ACCESSORIES

- A. (Kitchen) Multi-Purpose Dry Chemical Extinguisher (ABC): UL Rated 4A: 60B:C, 10 pound ammonium phosphate base dry chemical with red enamel steel shell, pressure gauge, and wall mounting bracket; similar to "No. 4010" by Croker or approved equal.
 1. Provide (ABC) fire extinguisher in fire extinguisher cabinet where indicated on Drawings for general purpose areas.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Verify existing conditions before starting work.
- C. Verify rough openings for cabinet are correctly sized and located.

3.2 INSTALLATION

- A. Fire Extinguisher Cabinets:
 1. Confirm exact locations with drawings. Coordinate final locations with Engineer and Department code official.
 2. Mount cabinets with tops to meet masonry coursing. Bottom of cabinets no lower than 4 inches above finished floor.
 3. Contractor to coordinate required wall recesses for cabinets.
 4. Securely fasten cabinets to wall.
 5. Provide solid blocking at all framed construction.
 6. Install in accordance with manufacturer's instructions.

7. Install cabinets plumb and level in wall openings, 44 inches from finished floor to inside bottom of cabinet unless otherwise noted on drawings.
8. Secure rigidly in place.
9. Place extinguishers and accessories in cabinets.

3.3 CLEANING AND PROTECTION

- A. After installation, clean soiled surfaces according to manufacturer's written instructions.
- B. Protect products from damage until acceptance by Owner.
- C. Protect adjacent surfaces from damage.
- D. Replace damaged or broken product.
- E. Dispose of waste legally and in accordance with local jurisdiction requirements.
- F. Comply with waste management and recycling program requirements.

END OF SECTION

SECTION 113100 – APPLIANCES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes but is not limited to the following:
 - 1. Kitchen appliances.

1.3 REFERENCE STANDARDS

- A. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Manufacturer's data indicating dimensions, capacity, and operating features of each piece of equipment specified.
- C. Operation and Maintenance Data: Submit operation and maintenance data for appliances in accordance with Form 817 Article 1.20-1.08.04 subsection 2 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.
- D. Copies of Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than 10 years of documented experience.
- B. Electric Appliances: Listed and labeled by UL and complying with NEMA standards.

1.6 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Provide five (5) year manufacturer warranty on refrigeration system of refrigerators.
- C. Provide ten (10) year manufacturer warranty on magnetron tube of microwave ovens.

PART 2 - PRODUCTS

2.1 KITCHEN APPLIANCES

- A. All Equipment Eligible for Energy Star Rating: Energy Star Rated.
- B. Refrigerator **RF1**: ADA Height, 24” width Free-standing, stainless steel low profile undercounter refrigerator with glass doors.
 - 1. Capacity: Total minimum storage of 15 cubic ft; minimum 0 percent freezer capacity.
 - 2. Energy Usage: Minimum 20 percent more energy efficient than energy efficiency standards set by.
 - 3. Commercially approved, listed to NSF-7 standards DOE and 100% CFC Free.
 - 4. Features: Built-in capable, double pane tempered glass door, adjustable glass shelves, internal fan, digital thermostat, recessed LED light, reversible door, open door alarm, fully finished black cabinet, frost-free operation.
 - 5. Finish: Stainless Steel exterior with glass door.
 - 6. Thin (14mm diameter) stainless steel handle mounted vertically.
 - 7. Manufacturers:
 - a. Summit Appliance; Model AL57G or approved equal.
- C. Freezer **FR1**: ADA Height, 24” width Free-standing, low profile undercounter freezer with solid stainless steel door and handle.
 - 1. Capacity: Total minimum storage of 3.5 cubic ft; minimum 100 percent freezer capacity.
 - 2. Energy Usage: Minimum 20 percent more energy efficient than energy efficiency standards set by DOE.
 - 3. Commercially approved, listed to NSF-7 standards DOE and 100% CFC Free.
 - 4. Features: Built-in capable, stainless steel door, manual defrost, -25° capable, three slide-out drawers, fully finished white cabinet, one piece interior liner, frost-free operation.
 - 5. Finish: Stainless Steel exterior.
 - 6. Manufacturers:
 - a. Accucold by Summit Appliance; Model VT65M7BISSHVADA or approved equal.
- C. Microwave Oven **MO1**: Over the counter.
 - 1. Capacity: Total minimum 1.7 cubic ft.
 - 2. Energy Usage: Minimum 20 percent more energy efficient than energy efficiency standards set by DOE.

3. Commercially approved, listed to NSF-7 standards DOE.
4. Features: Digital control and timer display.
5. Finish: Stainless Steel exterior.
6. Size: 29.88" width x 15" depth x 16.5" height.
7. Wattage: 1000 watt unit minimum.
8. Electric Power Supply: 120 V, 60 Hz, 1 phase, 15 AMP.
9. Manufacturers:
 - a. GE Profile Series Over-the-Counter Appliance; Model JVM6175SKSS or approved equal.

E. Microwave Oven **MO2**: ADA compliant built-in with glass doors.

1. Capacity: Total minimum 1.5 cubic ft.
2. Energy Usage: Minimum 20 percent more energy efficient than energy efficiency standards set by DOE.
3. Features: Turntable, digital control and timer display.
4. Finish: Stainless Steel exterior.
5. Size: 21 3/4" width x 16" depth x 13" height.
6. Electric Power Supply: 120 V, 60 Hz, 1 phase, 15 AMP. Power receptacle shall be provided within the cabinetry.
7. Wattage: 1000 watt unit.
8. Provide 30" deluxe stainless steel trim kit JX9153SJ (29 3/4" width x 19 1/8" height) for flush casework installation. Trim kit shall overalp over top of cabinetry by 1" on all sides.
9. Manufacturers:
 - a. GE Café Series Built-In capable Appliance; Model CEB1599SJSS or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions (by Installer/Applicator): Examine conditions under which products of this section are to be installed in coordination with Installer of materials and components specified in this Section and notify the Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Verify surface is free of liquid curing compounds and incompatible products with sealer.
- C. Verify utility rough-ins are installed and correctly located.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Anchor built-in equipment in place.

3.3 CLEANING

- A. Remove packing materials from equipment.
- B. Wash and clean equipment.

END OF SECTION

SECTION 122113 - LOUVER BLINDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Horizontal louver blinds with aluminum slats.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood blocking and grounds for mounting horizontal louver blinds and accessories.

1.2 ACTION SUBMITTALS

- ##### A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- ##### B. Product Data: For each type of product.

- ##### C. Samples: For each exposed product and for each color and texture specified, 12 inches.

- ##### D. Product Schedule: For horizontal louver blinds. Use same designations indicated on Drawings.

1.3 INFORMATIONAL SUBMITTALS

- ##### A. Product Test Reports: For horizontal louver blinds with polymer slats that have been tested for compliance with NFPA 701, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.4 SPARE PARTS

- ##### A. Furnish to the Engineer spare parts that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Horizontal Louver Blinds: Full-size units equal to 5 percent of quantity installed for each size, color, texture, pattern, and gloss indicated, but no fewer than two units.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver horizontal louver blinds in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Do not install horizontal louver blinds until construction and wet-work and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where horizontal louver blinds are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Engineer of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain horizontal louver blinds from single source from single manufacturer.

2.2 HORIZONTAL LOUVER BLINDS, ALUMINUM SLATS

- A. Basis of Design: Details and specifications are based on Riviera Sheer View 1” blind by Levelor. Other Manufacturer’s that may be acceptable upon a compliance review include:
 - 1. CACO, Inc., Window Fashions
 - 2. Hunter Douglas
 - 3. Or Approved Equal.
- B. Descriptions: Aluminum Slats; alloy and temper recommended by producer for type of use and finish indicated; with crowned profile and radius corners.
 - 1. Description: Horizontal slat louvers hung from full-width headrail with full-width bottom rail.
 - 2. Blinds: Horizontal slat louvers hung from full-width headrail with full-width bottom rail; manual control of raising and lowering by cord with full range locking; blade angle adjustable by control wand; complying with WCMA A100.1.

3. Metal Slats: Spring tempered pre-finished aluminum; square slat corners, with manufacturing burrs removed.
 - a. Width: 1 inch.
 - b. Thickness: 0.008 inch.
 - c. Perforated Slats: Openness factor of 6 to 7 percent to match existing horizontal blinds within the existing building.
 - d. Spacing: To match existing horizontal blinds within the existing building.
 - e. Color:
 - 1) HLB1 - @ Conference Room G302, the blind color shall match the existing dark grey color within the existing highway operations center.
 - 2) HLB2 - @ Exterior Storefront wall, the blind color shall match the existing standard building pink color.
4. Slat Support: Woven polypropylene cord, ladder configuration.
5. Head Rail: Pre-finished, formed aluminum box, with end caps; internally fitted with hardware, pulleys, and bearings for operation; same depth as width of slats.
6. Bottom Rail: Pre-finished, formed aluminum with top side shaped to match slat curvature; with end caps. Color: Same as headrail.
7. Control Wand: Extruded solid plastic; hexagonal shape.
8. Non-removable type.
9. Length of window opening height less 3 inches.
10. Color: Clear.
11. Headrail Attachment: Wall brackets.

2.3 HORIZONTAL LOUVER BLIND FABRICATION

- A. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.
 1. Lift-and-Tilt Mechanisms: With permanently lubricated moving parts.
- B. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F:
 1. Blind Units Installed between (inside) Jambs or vertical mullions: Width equal to 1/4 inch per side or 1/2 inch total, plus or minus 1/8 inch, less than jamb-to-jamb dimension of opening in which each blind is installed. Length equal to 1/4 inch, plus or minus 1/8 inch, less than head-to-sill dimension of opening in which each blind is installed.
- C. Installation Brackets: Designed for easy removal and reinstallation of blind, for supporting headrail, valance, and operating hardware, and for hardware position and blind mounting method indicated.
- D. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to blind hardware and adjoining construction; type designed for securing to supporting substrate; and supporting blinds and accessories under conditions of normal use.

- E. Color-Coated Finish:
 - 1. Metal: For components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.
- F. Component Color: Provide rails, cords, ladders, and exposed-to-view metal, wood, and plastic matching or coordinating with slat color, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install horizontal louver blinds level and plumb and aligned with adjacent units according to manufacturer's written instructions, and located so exterior slat edges in any position are not closer than 2 inches to interior face of glass. Install intermediate support as required to prevent deflection in headrail. Allow clearances between adjacent blinds and for operating glazed opening's operation hardware if any.
- B. Jamb Mounted: Install headrail flush with face of opening jamb and head.

3.3 ADJUSTING

- A. Adjust horizontal louver blinds to operate smoothly, easily, safely, and free of binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean horizontal louver blind surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that horizontal louver blinds are without damage or deterioration at time of the issuance of the Certificate of Compliance.

- C. Replace damaged horizontal louver blinds that cannot be repaired, in a manner approved by the Engineer.

END OF SECTION 122113

SECTION 123213 - MANUFACTURED WOOD-VENEER-FACED CASEWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes manufactured wood-veneer-faced cabinets of stock design.

1.2 DEFINITIONS

- A. Definitions in the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" apply to the work of this Section.
- B. MDF: Medium-density fiberboard.
- C. Hardwood Plywood: A panel product composed of layers or plies of veneer, or of veneers in combination with lumber core, hardboard core, MDF core, or particleboard core, joined with adhesive and faced both front and back with hardwood veneers.

1.3 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

1.4 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show fabrication details, including types and locations of hardware. Show installation details, including field joints and filler panels. Indicate manufacturer's catalog numbers for casework.
- D. Keying Schedule: Include schematic keying diagram and index each key set to unique designations that are coordinated with the Contract Documents.
- E. Samples for Verification: 8-by-10-inch Samples for each type of finish.
 - 1. One full-size finished base cabinet complete with hardware, doors, and drawers.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.
- C. Sample Warranty: For special warranty.

1.6 SPARE PARTS

- A. Furnish to the Engineer a complete touchup kit for each type and finish of casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged casework finish.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation of units required for this Project and who is a certified participant in the AWI's Quality Certification Program.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver casework only after painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate casework have been completed in installation areas. If casework must be stored in other-than-installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- B. Keep finished surfaces covered with polyethylene film or other protective covering during handling and installation.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period. Maintain temperature and relative humidity during the remainder of the construction period in range recommended for Project location by the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."

- B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.
- C. Locate concealed framing, blocking, and reinforcements that support casework by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.10 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Delamination of components or other failures of glue bond.
 - b. Warping of components.
 - c. Failure of operating hardware.
 - d. Deterioration of finishes.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain wood-veneer-faced casework from single manufacturer.

2.2 CASEWORK, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
 - 1. Grade: Premium.
 - 2. Provide labels and certificates from AWI certification program indicating that casework, including installation, complies with requirements of grades specified.
- B. Product Designations: Drawings indicate sizes, configurations, and finish materials of manufactured wood-veneer-faced casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer

configurations, of same finish materials, and complying with the Specifications may be considered.

- C. Product Designations: Drawings indicate configurations of manufactured wood-veneered casework by referencing designations of Casework Design Series numbering system in Appendix A of the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."

2.3 WOOD-VENEER-FACED CABINETS

A. Design:

1. Lipped overlay with radiused wood edges and full-width, recessed finger pulls machined into faces of doors and drawers.
2. Reveal overlay with recessed finger pulls machined into faces of doors and drawers.
3. Flush overlay.
4. Shall match adjacent veneer wood finish of the Wood wall panel coverings WWP-1.

B. Wood Species: as required to match Wood wall panel coverings WWP-1.

C. Face Veneer Cut: as required to match Wood wall panel coverings WWP-1.

D. Veneer Matching:

1. None required; select and arrange veneers for compatible grain and color.
2. Provide veneers for each cabinet from a single flitch, book and running matched as required to match Wood wall panel coverings WWP-1.
 - a. Provide continuous matching of adjacent drawer fronts within each cabinet.
3. Provide veneers for each elevation from a single flitch, book and running matched as required to match Wood wall panel coverings WWP-1.
 - a. Provide continuous matching of adjacent drawer fronts within each cabinet and end matching between drawer fronts of adjacent cabinets.

E. Grain Direction:

1. Vertical on both doors and drawer fronts, with continuous vertical matching.
2. Vertical on doors, horizontal on drawer fronts.
3. Lengthwise on face frame members.
4. Vertical on end panels.
5. Side to side on bottoms and tops of units.
6. Vertical on knee-space panels.
7. Horizontal on aprons.

F. Exposed Materials:

1. Plywood: Hardwood plywood with face veneer of species indicated, selected for compatible color and grain. Provide backs of same species as faces.
2. Solid Wood: Clear hardwood lumber of species indicated and selected for grain and color compatible with exposed plywood.

G. Semiexposed Materials:

1. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects, of any species similar in color and grain to same species as exposed wood.
2. Plywood: Hardwood plywood of any species similar in color and grain to same species as exposed wood. Provide backs of same species as faces.
3. Provide solid wood or hardwood plywood for semiexposed surfaces unless otherwise indicated.
4. Hardboard: Use only for cabinet backs where exterior side of back is not exposed.
5. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.

H. Concealed Materials:

1. Plywood: Hardwood plywood. Provide backs of same species as faces.

2.4 MATERIALS

- A. Low-Emitting Materials: Fabricate manufactured wood casework, including countertops, with adhesives and composite wood products containing no urea formaldehyde.
- B. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated; made without urea formaldehyde. Softwood Plywood: DOC PS 1.
- C. Hardboard: ANSI A135.4, Class 1 Tempered.
- D. Edgebanding: Minimum 1/8-inch thick, solid wood of same species as face veneer and wood veneer of same species as face veneer
1. Select wood edge banding for grain and color compatible with face veneers.
 2. Colors: As selected by Designer from manufacturer's full range and as required to match Wood wall panel coverings WWP-1.
- E. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.

2.5 COLORS AND FINISHES

- A. Wood Colors and Finishes: As selected by Designer from casework manufacturer's full range and as required to match Wood wall panel coverings WWP-1.

2.6 FABRICATION

- A. Wood-Veneer-Faced Cabinet Construction: As required by referenced quality standard, but not less than the following:
 - 1. Bottoms of Cabinets and Tops of Wall Cabinets: 3/4-inch veneer-core hardwood plywood.
 - 2. Ends of Cabinets: 3/4-inch hardwood plywood.
 - 3. Shelves: 3/4-inch veneer-core hardwood plywood or 1-inch particleboard-core hardwood plywood.
 - 4. Base Cabinet Top Frames: 3/4-by-2-inch solid wood with mortise and tenon or doweled connections, glued and pinned or screwed.
 - 5. Base Cabinet Stretchers: 3/4-by-4-1/2-inch plywood, particleboard, or MDF strips or solid-wood boards at front and back of cabinet, glued and pinned or screwed.
 - 6. Base Cabinet Subtops: 3/4-inch panel product, glued and pinned or screwed.
 - 7. Backs of Cabinets: 3/4-inch particleboard-core hardwood plywood where exposed, 1/2-inch hardwood plywood, dadoed into sides, bottoms, and tops where not exposed.
 - 8. Doors More Than 48 Inches in Height: 1-1/16 inches thick, with solid hardwood stiles and rails, honeycomb cores, and hardwood face veneers and crossbands.
- B. Filler Strips: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets.

2.7 FINISH

- A. Preparation: Sand lumber and plywood for manufactured wood casework construction before assembling. Sand edges of doors and drawer fronts and molded shapes with profile-edge sander. Sand casework after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.
- B. Staining: Remove fibers and dust and apply wash-coat sealer and stain to exposed and semiexposed surfaces as required to provide uniform color and to match approved samples.
- C. Finishing Closed-Grain Woods: Apply manufacturer's standard two-coat, baked, clear finish consisting of a thermosetting catalyzed sealer and a thermosetting catalyzed conversion varnish. Sand and wipe clean between applications of sealer and topcoat. Topcoat may be omitted on concealed surfaces.

- D. Finishing Open-Grain Woods: Apply manufacturer's standard three-coat, baked, clear finish consisting of a thermosetting catalyzed sealer and two coats of a thermosetting catalyzed conversion varnish. Sand and wipe clean between applications of sealer and topcoat and between topcoats. Topcoats may be omitted on concealed surfaces.

2.8 CASEWORK HARDWARE AND ACCESSORIES

- A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard champagne gold finish stainless steel, commercial-quality, heavy-duty hardware.
 - 1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard, except where hardware is through bolted from back side.
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, Type B01602, 135 degrees of opening, self-closing. Provide two hinges for doors less than 48 inches high, and provide three hinges for doors more than 48 inches high.
- C. Pulls: Solid stainless-steel wire pulls, fastened from back with two screws. For sliding doors, provide recessed stainless-steel flush pulls. Provide two pulls for drawers more than 24 inches wide.
- D. Door Catches: Zinc-plated dual, self-aligning, permanent magnet catch. Provide two catches on doors more than 48 inches high.
- E. Drawer and Hinged Door Locks: Cylindrical (cam) type, five-pin tumbler, brass with chrome-plated finish, and complying with BHMA A156.11, Grade 1.
 - 1. Provide a minimum of two keys per lock and six master keys.
 - 2. Provide locks where indicated on all doors and drawers.
- F. Sliding-Door Hardware Sets: Manufacturer's standard, to suit type and size of sliding-door unit.
- G. Adjustable Shelf Supports: Mortise-type, zinc-plated steel standards and shelf rests complying with BHMA A156.9, Type B04071 and Type B04091.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CASEWORK INSTALLATION

- A. Grade: Install cabinets to comply with same grade as item to be installed.
- B. Install casework level, plumb, and true; shim as required, using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Bolt adjacent cabinets together with joints flush, tight, and uniform.
- D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch.
- E. Fasten cabinets to adjacent cabinets and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
- F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.
- G. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 CLEANING

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by the Engineer.

END OF SECTION 123213

SECTION 123216 - PLASTIC LAMINATE CASEWORK

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes, but is not limited to, the following:

1. Plastic laminate faced casework - Overlay door design, including (but not limited to): Wall and base cabinets
2. General millwork and custom cabinetry specified herein or so noted on plans as included within this section.
3. Accessory items, including but not limited to the following:
 - a. All filler panels, frame units, scribe strips, strips at walls, and similar items.
 - b. Cutouts for sinks, faucets, fittings, and other plumbing and electrical fixtures, electrical and mechanical runs and connections and similar items.
 - c. Materials and devices necessary to make solid connections to existing structure.
 - d. Toe base to match casework material.
 - e. Blocking within walls.
 - f. Fixture installation/services connections: Setting and installation of equipment and fixtures, and related utility connections, are provided under the other sections of the Project Specification governing that utilities.

1.1 REFERENCES

- A. Designerural Woodwork Institute
- B. ASTM E84
- C. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; Hardwood Plywood & Veneer Association; 2004 (ANSI/HPVA HP-1).
- D. NEMA LD 3 - High-Pressure Decorative Laminates; National Electrical Manufacturers Association; 2005.
- E. NEMA LD3-2000 CL5 standards
- F. ANSI/BHMA A156.9

1.2 SYSTEM DESCRIPTION

- A. Design Requirements: Refer to drawings to establish required casework unit function and dimension as well as standard of quality for casework construction. Using dimensions and configurations shown on drawings provide standard casework units and modify as required to provide configurations and arrangements shown. Casework of other nationally - recognized casework manufacturers may be considered for acceptance provided casework conforms to design, quality of materials, design intent, workmanship and exact performance function of casework components and details specified and implied by listed manufacturer's references, regardless of proposed manufacturer's "product standards" and design requirements.
- B. Performance Requirements:

1. Barrier Free: Comply with current Connecticut Accessibility code requirements.
2. Drawer Suspension:
 - a. Dynamic (Operational) Load Rating: Minimum 100 lbs.
 - b. Static Load Rating: Minimum 150 lbs.
3. “Architectural Woodwork Institute” – Premium Grade Construction Standards for Casework Construction. Including but not limited to:
 - a. Joint Tolerances 400C-T-1.
 - b. Finish Test 400C-T-2.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- A. Product Data: Submit manufacturer's data and installation instructions, including descriptions of each item identifying parts and accessories, materials, and other information necessary to establish conformance with requirements indicated.
- B. Shop Drawings:
 1. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size of casework, and type of fasteners, and accessories.
 2. Roughing Drawings: Submit roughing drawings, showing complete roughing dimensions for plumbing, ventilating and electric services and components to be installed in casework, including location of existing roughing and dimensions, where applicable. Drawings to be a minimum of ¼ inch scale.
 3. Groups/Assemblies: Submit shop drawings of groups or assemblies, including descriptions identifying units, parts, and accessories of each item and showing materials, dimensions, cabinet-cut details, and sink locations (where applicable).
- C. Samples:
 1. Casework Units: Without cost to Owner, submit samples, as requested, to demonstrate Contractor's ability to furnish required casework.
 2. Color Selection: Submit samples of finishes, colors, and materials as required for color selection.
- D. Quality Control Submittals:
 1. Test Reports: Submit certified product test data demonstrating compliance with requirements specified above in "Systems Description, Performance Requirements".
 2. Qualifications Certification: Submit written certification or similar documentation signed by applicable subcontractor, Prime Contractor and manufacturer (where applicable) indicating compliance with applicable “Qualifications” requirements specified below in “Quality Assurance.”
 3. Installer Experience Listing: Submit list of completed projects using products proposed for this Project, including owner’s contact and telephone number for each project, demonstrating compliance with applicable “Qualifications” requirements specified below in “Quality Assurance.”

- E. Maintenance Data: For casework to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS. Include the following:
 - 1. Requirements and recommendations for lubrication, general care, maintenance, operating adjustments, and parts lists covering casework and other related items indicated.

1.4 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer: Minimum (5) years of experience in manufacture of casework and other items similar to those specified and minimum (5) five completed casework installations of similar size and requirements to that specified. Provide manufacturers written certification of installer.
 - 2. Installer: Minimum (5) completed casework installations of similar size and requirements to that specified.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver all casework in one piece where possible. When impractical to do so, deliver casework in sections and assemble in position under supervision of authorized factory mechanic.
- B. Acceptance at Site: Deliver all casework to Site as required, and provide Contractor personnel to receive and handle casework items; Owner or other contractors at Site shall not store or handle any casework items.
- C. Storage and Protection: Deliver all casework in manner to protect against dirt, water, chemical and mechanical injury. Protect casework in transit. Store under cover in ventilated building not exposed to extreme temperature and humidity changes. Do not store or install casework in building until concrete, masonry, and drywall/plaster work is dry.

1.6 PROJECT/SITE CONDITIONS

- A. Field Measurements: Prior to fabrication or ordering of any specified casework items, verify measurement at Site of actual space reserved for casework items; DO NOT take measurements from Contract Drawings. Give due consideration to Architectural, structural, or mechanical discrepancies occurring during building construction. Make such discrepancies immediately known to Designer and obtain clarification of discrepancy in writing before proceeding with installation of affected casework items.
- B. Coordinate work of this Section with related work of other Sections as necessary to obtain proper installation of all items.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate installation of other related work within the casework.
 - 1. Plumbing Coordination: Provide, install, and connect to building plumbing systems all plumbing fittings and fixtures, i.e. water faucets, sink drains, tailpieces, etc.
 - a. Install standard features of casework items provided with casework.
 - b. Casework Installer provides cutouts in casework for fittings and fixtures.

2. Electric Coordination: Provide, install, and connect to building electrical system all electrical fittings, i.e. duplex outlets and similar items.
 - a. Install standard features of casework items and provided with casework.
 - b. Casework Installer provides cutouts in casework for fittings and fixtures included in Electric Work Prime Contract.

1.8 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Manufacturer's Warranty: All materials shall be guaranteed for five (5) years from manufacturer's defects and workmanship.
 1. Warranty: Submit a written warranty signed by the manufacturer, the contractor, and the installer, guaranteeing to correct failures in materials and workmanship which occur within the warranty period, including those attributable to abnormal aging, without reducing or otherwise limiting any other rights to correction which the owner may have under the contract documents.
 2. The Manufacturer shall warrant the casework to be free from defects in materials and workmanship, under normal use and service, for five (5) years from date of substantial completion. Within the warranty period, the Manufacturer shall repair and replace defective casework.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. As a basis of design, details and specifications have been based on “New Century Line L44 Series” by LSI Corporation of America, Inc., Minneapolis, Minnesota.
- B. Other manufacturers that may be acceptable upon a compliance review include the following:
 3. TMI Systems Design Corporation, Dickinson, North Dakota: “Trim Line Series”.
 4. Stevens Industries Inc., Teutopolis, Illinois
 5. Case Systems Inc., Midland, Michigan.
 6. Or Approved Equal.
- C. Single Source: Obtain casework and accessories from same casework supplier to establish single responsibility for all casework components.

2.2 MATERIALS

- A. Minimum Component Flammability Requirements: Provide casework with components meet following requirements to achieve minimum of “Class C” rating per ASTM E84.

Flame Spread Smoke Developed

1. Exterior High Pressure Laminate:	30	30
2. High Pressure Laminate Exterior Bonded to High Performance Non-Formaldehyde Core Material:	165	135
3. High Pressure Laminate Exterior Bonded to High Performance Particleboard Core Material:	165	135

B. Laminated Plastics/Finish:

1. High Pressure Plastic Laminate: 0.030 inch thick, for exterior cabinet surfaces, and interior of open cabinets, meeting NEMA LD3-2000 VG5 standards including thickness.
 - a. PLAM 1:
 - (1) Color: Similar to “Nevamar” – Chalk White or approved equal.
 - (2) Finish: Similar to Pattern S7024, “Nevamar” – Barnboard (BB) or approved equal.
 - b. PLAM 2:
 - (1) Color: Similar to “Pionite” – Negotiating In Genevae or approved equal.
 - (2) Finish: Similar to Pattern PFA60, “Pionite” – Textured Suede (SD) or approved equal.
2. Plastic Laminate Balancing Sheet: Cabinet liner; Designer to select from manufacturers full range of colors, 0.020 inch thick meeting NEMA LD3-2000 CL5 standards. Used for balancing exterior surface laminates.
3. Countertop: Refer to Countertop specification in Division 12.
4. Pressure Fused Laminate: Melamine resin impregnated, 80 gram PSM minimum, surface laminated to core under pressure and meeting NEMA LD3.3-2000 GP standards and NEMA LD3-2000 CL20 standards.
 - a. Pressure fused laminate for exposed cabinet interiors without doors, open units, cubbies and at exterior underside of wall cabinets. Color to be selected by Designer from manufacturer’s full range of standard textures, patterns and solid lines, minimum of at least (12) standard colors.
 - b. Provide balancing phenolic backer at all concealed surfaces; un-surfaced core-board not acceptable.
5. Laminate Adhesive: Water based low volatile organic compound (VOC), Non-Tonic, PVA adhesive.

C. High Performance Non – Formaldehyde Core: Non – formaldehyde fiber composition board with non-toxic emission-free binders, engineered to meet the performance requirements of ANSI A208.1-1999, grade M-3.

1. Similar to “LSI EnvironmentCore” - Other products which are approved formaldehyde free core materials:
 - a. Agrifiberboard by TMI Systems.
 - b. Woodstalk by Dow BioProduct
 - c. Or approved equal

2. Provide following minimum core thicknesses prior to lamination for following high performance core cabinet components:
 - a. Cabinet Backs: 1/2 inch.
 - b. Dividers, as detailed: 1/2 inch.
 - c. Base and Tall Cabinet Tops and Bottoms, Cabinet Sides, Drawer Spreaders, Door, Drawer Head, Cabinet Back Rear Hangstrips, Dividers (as detailed), Exposed Cabinet Backs: 3/4 inch.
 - d. Wall Cabinet Tops and Bottoms: 1 inch
 - e. Interior Shelving - 3 ft. long or less: 3/4 inch
 - f. Interior or Exterior Shelving - over 3 ft. long: 1 inch

D. Edging:

1. Types:
 - a. 0.020mm PVC: 0.020mm, solid, high impact, purified, color-thru, acid resistant PVC edging machine-applied with hot melt adhesives, automatically trimmed face, back and corners for uniform appearance.
 - b. 3mm PVC: Solid, high impact, purified, color-thru, acid resistant, pre-lamination primed edging, machine-applied with hot melt adhesives, automatically trimmed, inside/outside length-radiused for uniform appearance, buffed and corner-radiused for consistent design. As selected by Designer from full range of standard and custom colors.
2. Edging Locations:
 - a. Door/Drawer Front Edge – Bodies of Open Cabinets and Cubbies, (including shelves in open units) support panel exposed edge: 3mm PVC.
 - b. Cabinet Body Edge (including door/drawer front spacer rail): 0.020mm PVC.
 - c. Interior Body Component Edging, Interior Dividers, Top of Drawer Body, Shelf: 0.020mm PVC to match cabinet exterior surface color, PVC on all sides of shelf.
 - d. Colors as selected by Designer from full range of colors.

E. Hardware:

1. Hinges: Heavy duty, 5-knuckle 2-3/4 inches institutional type hinge, meeting ANSI/BHMA A156.9 Grade 1 requirements. Mill ground, hospital tip, tight pin feature with all edges eased. Full wrap around type of tempered steel 0.095 inch thick. Each hinge includes minimum 9 screws, #7, 5/8 inch FHMS to assure positive door attachment.
 - a. Provide 1 pair per door to 48 inches high; 1-1/2 pair over 48 inches high. Accommodates 13/16 inch thick laminated door and allows 270 Degree swing.
 - b. Finish: Chrome Coat Powder Finish. Color selected by Designer from full range of colors.
2. Pulls: As selected by Designer from manufacturer's full range of pulls compliant with Americans with Disabilities Act, Federal Register Volume 56, No. 144, Rules and Regulations.
3. Catches: 1 top-mounted magnetic catch for base, wall and 1 top-mounted and mid-height catch at tall cabinet doors; housing molded in white. Compliant with opening resistance in Americans with Disabilities Act.

4. Adjustable Shelf Supports: Twin-pin design with anti-tip-up shelf restraints for both 3/4 inch and 1 inch shelves. Includes keel to retard shelf slide-off, and slot to mechanically attach shelf to clip.
 - a. Load Rating: Minimum 300 lbs. each support without failure; refer to "System Description, Performance Requirements" above.
 - b. Cabinet Interior Sides: Flush, without shelf system permanent projection.
5. Locks: Disc tumbler lock, keyed alike per room and master keyed Dull chrome finish.
 - a. Hinged Doors and Drawers: Similar to: National Lock No. M4-7054
 - b. Sliding Doors (13/16 inch thick): Similar to: National Lock No. M4-0057
 - c. Locks are to be furnished on all doors and drawers as indicated in the drawings.

2.3 COMPONENTS

A. Cabinet Construction:

1. Sub-Base: Separate and continuous (no cabinet body sides-to-floor), water resistant exterior grade plywood with concealed fastening to cabinet bottom. Ladder-type construction of front, back and intermediates to form a secure and level platform to which cabinets attach.
2. Cabinet Top and Bottom: Solid sub-top furnished for all base and tall cabinets.
 - a. Wall Cabinet Bottoms and Tops: 3/4" inch thick.
 - b. Exterior Exposed Wall Cabinet Bottoms: Pressure-fused laminate both sides. Assembly devices concealed on bottom side of wall cabinets.
3. Cabinet Ends: Holes drilled for adjustable shelves 1-1/4 inch on center. Exposed exterior cabinet ends laminated with high pressure plastic laminate and balanced with high pressure cabinet liner interior surface.
4. Cabinet Backs: Firmly secured to or into sides, top, and bottom, recessed 7/8 inch from cabinet rear. Rear, unexposed, side of back receives continuous bead of hot melt adhesive at joint between back and sides/top/bottom. Use of staples to secure backs not acceptable.
 - a. Hang rails glued to rear of cabinet back and mechanically fastened to cabinet sides; minimum of 2 at base, 2 at wall, and 3 at tall cabinets.
 - b. Exposed exterior backs high pressure plastic laminate balanced with high pressure cabinet liner; exposed particleboard backs not acceptable.
5. Door And Drawer Fronts:
 - a. Laminated Door and Drawer Fronts: Minimum 3/4 inch thick. Drawer fronts and hinged doors overlay cabinet body. Maintain maximum 1/8-inch reveal between pairs of doors, between door and drawer front, or between multiple drawer fronts within cabinet.
 - b. Stile and Rail Doors: Where shown on drawings, provide 13/16 inch thick with full 1/4 inch tempered glass; hinged or sliding as indicated by specified manufacturer's catalog number. All exposed lite-opening edges trimmed and glazed with extruded vinyl glazing bead.
6. Drawers:
 - a. Drawer Fronts: Applied to separate drawer body component sub-front.

- b. Drawer Sides: Dadoed, rabbeted, or doweled and glued to receive front and back, machine squared and held under pressure while hot melt glued and pinned together; stapled fastening not acceptable.
 - c. Drawer Bottom: Securely fastened to front, sides, and back using rabbets or dados; stapled fastening not acceptable. Underside of drawer receives continuous bead of hot melt adhesive at joint between bottom and back/sides/front for sealing and rigidity. Drawer bottoms reinforced with 1/2 inch x 4 inches front-to-back intermediate underbody stiffeners, hot melt glued and fastened. Bottom fully captured by drawer glides.
 - d. Paper Storage Drawers: Fitted with full width hood at back.
 - e. Suspension (all drawers): Roller guides as specified above in "Materials - Hardware".
7. Vertical and Horizontal Dividers:
- a. Hardboard: Natural hardboard 1/4 inches thick, smooth both faces. Secured in cabinet with molded plastic clips.
 - b. Fused Laminate: Pressure fused laminate 3/4-inch thickness. Secured in cabinet with molded plastic clips or dowels.
8. Door/Drawer Front Rail: Provide minimum 3/4 inch x 6 inches x full width cabinet body rails immediately behind all door/drawer and multiple drawer horizontal joints.
9. Barrier Free Design: Comply with following special requirements, where specifically indicated on Drawings as "ADA" or "H.C."
- a. Countertop Height: With or without cabinet below, not to exceed a height of 34 inches above finished floor, at surface depth of 24 inches.
 - b. Knee-space Clearance: Minimum 27 inches above finish floor and 30 inches clear span width.
 - c. Adjustable or Fixed 12 inches Deep Shelving: not exceeding 9 inches to 54 inches above finish floor.
 - d. Wardrobe Cabinets: Where shown on drawings, provide cabinets with rod/shelf adjustable to 48 inches above finish floor at maximum 21 inches shelf depth.
 - e. Sink Cabinet Clearances: In addition to "Knee-space Clearance" above, upper knee-space frontal depth not less than 8 inches, and lower toe frontal depth not less than 11 inches, at point 9 inches above finish floor, provide outlet in back corner of sink bowl. Coordinate with Plumbing drawings and as further described in NJAC 5:23-7 (2013) and ANSI A117.1-03.
- B. Countertops: Refer to Countertop specification in Division 12.
- C. Fabrication:
- 1. High-pressure laminate provided on all exposed exterior cabinet surfaces. Laminate surface/ balancing liner applied to core under controlled conditions, by approved and regulated laminating methods for premium lamination. Methods requiring heat and "contact" methods of laminating not acceptable.
 - 2. Cabinet parts accurately machined and bored for "premium grade" quality joinery construction utilizing automatic machinery to insure consistent sizing of modular components. End panels doweled to receive bottom and top.

3. Back panel fully secured to or recessed 7/8 inch from back of cabinet sides, top, and bottom ensuring rigidity and fully closed cabinet. Cabinet back shimmed from rear of body for tight interior fit. Staple attachment of back panel not acceptable.
4. Drawer bottom fully housed into or fully captured on 2 sides by drawer runner hardware. Sides of drawer fully dadoed to receive drawer back, locked in fully to sub front and back, fastened with glue and mechanical fasteners.
5. Hang rails, 3/4 inch thick, glued to backside and mechanically fastened to end panels of all wall, base, and tall cabinets.
6. Rear of cabinet back and underside of drawer bottom joints have continuous bead of hot melt adhesive.
7. All cases fabricated square, plumb, and true.
8. Removable back panels and closure panels provided for access where shown on Drawings or as required for HVAC units.
9. Grilles: Install continuous grilles in locations noted on Drawings.

2.4 ACCESSORIES

A. Wood Slat Wall:

1. Similar to "PDI Palay Display Industries" - Walnut Slat wall Panel Model # 6278WT or approved equal.
2. Color: Walnut textured
3. Size: 8' wide by 2' high.
4. Slots: At slots are 6" on center. Top and bottom edge slots are standard.

B. Brick Slat Wall:

1. Similar to "PDI Palay Display Industries" – White Brick Slat wall Panel Model # 6278WH or approved equal.
2. Color: White textured
3. Size: 8' wide by 2' high.
4. Slots: At slots are 6" on center. Top and bottom edge slots are standard.

C. Glass Shelving:

1. Similar to "PDI Palay Display Industries" – Annealed Glass Shelving, Flat Polished or approved equal.
2. Material: 3/8" Annealed Glass
3. Size: Model # 1620 Annealed Glass, Flat Polished - 12" x 24" x 3/8"
 - a. Provide two (2) Slatwall Shelf Bracket - 12" Chrome – Model # 1620 per shelf
 - (1) Quantity: Provide twelve (12)
 - (2) Provide two (2) Shelf Bracket Bumper – Model # 1836 per Shelf Bracket
4. Size: Model # 1621 Annealed Glass, Flat Polished - 12" x 36" x 3/8"
 - a. Provide three (3) Slatwall Shelf Bracket - 12" Chrome – Model # 1621 per shelf
 - (1) Quantity: Provide twelve (12)
 - (2) Provide two (2) Shelf Bracket Bumper – Model # 1836 per Shelf Bracket

D. Chrome 4" Hooks:

1. Similar to "PDI Palay Display Industries" – Chrome 4" Hooks – Model # 2522 or approved equal.
 - a. Quantity: Provide twenty-four (24)

E. Chrome 6" Hooks:

1. Similar to "PDI Palay Display Industries" – Chrome 6" Hooks – Model # 2523 or approved equal.

- a. Quantity: Provide twenty-four (24)
- F. Chrome 6" Straight Arms:
 - 1. Similar to "PDI Palay Display Industries" – Chrome 6" Straight Arms – Model # KIT604 or approved equal.
 - a. Quantity: Provide six (6)
- G. Chrome Square Tube Slatwall Waterfall:
 - 1. Similar to "PDI Palay Display Industries" – Chrome Square Tube Slatwall Waterfall – Model # KIT607 or approved equal.
 - a. Quantity: Provide six (6)
- H. Clear Acrylic Slatwall Jewelry T-Bar:
 - 1. Similar to "PDI Palay Display Industries" – 10" Clear Acrylic Slatwall Jewelry T-Bar – Model # 2343 or approved equal.
 - a. Quantity: Provide six (6)

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which plastic laminate faced casework is to be installed in coordination with Installer of materials and components specified in this Section and notify Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.2 INSTALLATION

- A. Install casework under supervision of factory-trained installation superintendent. Provide all bolts, blocking, miscellaneous items necessary for complete working installation in existing space.
- B. Install casework plumb and level, properly aligned between sections and neatly finished at walls and floors. Ensure smooth operation of working parts without binding. Scribe and closely fit to adjacent work. Cut and fit work around pipes, ducts and similar construction.
- C. All joints and seams will be caulked a color as selected by Designer. Refer to Division 07 for products.

3.3 ADJUSTING / CLEANING

- A. Upon completion of installation, leave adjusted and in perfect working order, including cleaning of new casework in accordance with manufacturer's recommended cleaning methods and procedures.
- B. After installation, clean all glue from casework and countertops.
- C. In addition to cleaning new casework, clean adjacent existing casework, equipment and surrounding construction soiled as result of casework installation.
- D. Remove all debris and surplus material.

- E. Dispose of waste legally and in accordance with local jurisdiction requirements.
- F. Clean up: Remove all cartons, debris, sawdust, scraps, etc., and leave spaces clean and all casework ready for owner's use.
- G. Comply with waste management and recycling program requirements.

END OF SECTION

SECTION 123600 – COUNTERTOPS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes but is not limited to the following:
 - 1. Quartz (Solid surface) countertops for architectural cabinetwork.
 - 2. Stainless steel support brackets.
 - 3. Accessories and setting materials.

1.3 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI):
 - 1. A108.5 - Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex Portland Cement Mortar.
 - 2. A118.4 - Latex-Portland Cement Mortar.
- B. ASTM International (ASTM):
 - 1. C97 - Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.
 - 2. C99 - Standard Test Method for Modulus of Rupture of Dimension Stone.
 - 3. C170 - Standard Test Method for Compressive Strength of Dimension Stone.
 - 4. C482 - Standard Test Method for Bond Strength of Ceramic Tile to Portland Cement.
 - 5. C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - 6. C615 - Standard Specification for Granite Dimension Stone.

1.5 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. 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. Specimen warranty.
 - 4. Indicate percentages by weight of post-consumer and pre-consumer recycled content for each product having recycled content.
 - 5. Include statement indicating cost for each product having recycled content.
 - 6. Indicate product, product manufacturer and related VOC content for all Adhesives and Sealants.

- C. Shop Drawings: Complete details of materials and installation; combine with shop drawings of cabinets and casework specified in other sections. Provide shop drawings for countertops, wall caps, and window sills. Provide seaming layout and joint details.
- D. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.
- E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.
- F. Maintenance Data: For countertops include maintenance manual to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 QUALITY ASSURANCE

- A. Fabricator and Installer Qualifications: Same fabricator as for cabinets on which tops are to be installed.
- B. Minimum 2 years documented experience in work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.9 FIELD 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.

PART 2 - PRODUCTS

2.1 COUNTERTOP ASSEMBLIES

- A. Quartz Countertops (Quartz or Solid Surface) have been specified around the following:
 - 1. Basis of Design: IceStone Durable Surfaces – Fogbound (not Gotham Gray)
- B. Other products that may be acceptable upon a compliance review include:

1. Cosentino
 2. Or Approved equal.
- C. Material: Provide counter tops and window sills made of Quartz / Solid surfacing sheet or plastic resin casting self-supporting over base cabinetry or wall construction.
1. Flat Sheet Thickness: 1-1/4 inch, minimum unless otherwise noted.
 2. Composition: Recycled glass ceramic granite aggregate, porcelain, mirror, and metals; quartz aggregate; corn-based resin; and color pigments formed into flat slabs.
 3. Physical characteristics:
 - a. Meet requirements of ASTM C615 and ANSI A137.1.
 - b. Static coefficient of friction: 1.41 dry, 0.50 wet, tested to ASTM C1028.
 - c. Water absorption:
 - 1) Maximum 0.02 percent, tested to ASTM C97.
 - 2) Maximum 0.03 percent, tested to ASTM C373.
 - d. Compressive strength: Average 22,156 psi, tested to ASTM C170.
 - e. Bond strength: Minimum 395 psi, tested to ASTM C482.
 - f. Modulus of rupture: Average 5424 psi, tested to ASTM C99.
 - g. Flexural strength:
 - 1) Average 5004 psi, tested to ASTM C880.
 - 2) Minimum 6283 psi, tested to ASTM C674.
 - h. Breaking strength: Average 2795 lbf, tested to ASTM C648.
 - i. Stain resistance; tested to ASTM C1378:
 - 1) Contrasting grout: No affect, cleaning Method A.
 - 2) Carbon lamp black: No affect, cleaning Method A.
 - 3) Black waterproof ink: No affect, cleaning Method D.
 - 4) Washable ink: No affect, cleaning Method D.
 - 5) Potassium permanganate solution, 1 percent: Affected, cleaning Method D.
 - 6) Methylene blue solution, 1 percent: No affect, cleaning Method D.
 - j. Thermal shock resistance: Pass 10 cycles, tested to ASTM C484.
 - k. Abrasion resistance: Average 79.40, tested to ASTM C1353.
 - l. Thermal expansion: 1.67 x 10⁻⁵ in/in/deg F, tested to ASTM C531.
 - m. Deicing resistance: Rating of 0, tested to ASTM C672/C672M.
 - n. Freeze/thaw resistance: 0 tiles at 15 cycles, tested to ASTM C1026.
 - o. Moisture expansion: Average 0.04 percent, tested to ASTM C370.
 - p. Flame spread rating: Class 1, tested to ASTM E84.
 - q. Smoke toxicity: LC50 value of 81.4 grams, tested to UPitt Test Protocol.
 - r. Moh's hardness: 6.0.
 - s. Color and Pattern: Fogbound or equivalent current color as selected by Designer in consultation with Owner Occupant from manufacturer's full range

of colors and patterns.

4. Exposed Edge Treatment: Built up to minimum 1-1/4 inch thick unless otherwise noted for counter tops;
 - a. Edge profile selected by the Designer from full range of edge options including, but not limited to; radius edge, eased edge, chamfered edge, square edge, etc.

2.2 ACCESSORY MATERIALS

- A. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- B. Joint Sealant:
 1. Laticil Tile and Stone Sealant by Laticrete International, Inc.
 - a. Volatile organic compound (VOC) content: Maximum 50 grams per liter.
 - b. Color: To match Fogbound countertop or equivalent current color as selected from manufacturer's full color range of standard and premium colors.
- C. Provide 3x3 stainless steel #304 support angel along wall surface where required for supplemental support of the countertop.

2.5 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 1. Join lengths of tops using best method recommended by manufacturer.
 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue with approved VOC levels.
 2. Height: 4 inches, unless otherwise indicated.
- C. Solid Surfacing / Quartz: Fabricate tops up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer's recommendations and

instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which products are to be installed in coordination with Installer of materials and components specified in this Section and notify of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Do not begin installation until substrates have been properly prepared.
- D. If substrate preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.
- E. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
- B. Attach epoxy resin countertops using compatible adhesive.
- C. Seal joint between back/end splashes and vertical surfaces.
 - 1. Where indicated use rubber cove molding.
 - 2. Where applied cove molding is not indicated use specified sealant.

3.4 INSTALLATION TOLERANCES

- A. Maximum variation from level and plumb: 1/8 inch in 10 feet, noncumulative.
- B. Maximum variation in plane between adjacent pieces at joint: Plus or minus 1/16 inch.

3.5 CLEANING

- A. Clean countertops surfaces thoroughly. Comply with manufacturer's requirements for cleaning chemicals.

3.6 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 124813 – ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Roll up matt in recessed depression with frame assemblies.

1.2 REFERENCE

- A. American Society for Testing and Material (ASTM).
- B. The Aluminum Association.
- C. The Carpet and Rug Institute (CRI).
- D. The National Floor Safety Institute (NFSI).

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Include manufacturer's specifications and installation instructions, construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of floor mat and frame specified, for each product indicated.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work: For floor mats and frames. Show assembly, joint locations, installation details, layout, plans, elevations, sections, details of patterns or designs, accessories, anchors, and attachments to other Work.
 - 1. Verify recesses and openings in substrates by field measurements before fabrication and indicate measurements on Shop Drawings. Provide center joint on all assemblies.
 - 2. Coordinate Shop Drawings showing oversized recess for deferred installation of frames with concrete work. Indicate extent of existing concrete to be removed and the methods for removal of the existing concrete for placement of the floor mats and frames. Jackhammering and/or sawing of the existing concrete slab is allowed. Oversize recess as required by manufacturer.
- D. Samples:
 - 1. Sample Selection: Provide sample for each type of floor mat and frame indicated.

2. Verification: 8-inch- square assembled sections of floor mats, frame members, and tread rails with selected tread surface showing each type of metal finish and color of exposed floor mats, tread rails, frames, and accessories required.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Flammability in accordance with ASTM E648, Class 1, Critical Radiant Flux, minimum 0.45 watts/m².
2. Slip resistance in accordance with ASTM D-2047-96, Coefficient of Friction, minimum 0.60 for accessible routes.
3. Standard rolling load performance to be 1000 lb. / wheel (load applied to a solid 5 inches x 2 feet wide polyurethane wheel, 1000 passes without damage).
4. Single Source Responsibility: Obtain floor mats/grids and frames from one source of a single manufacturer.
5. Utilize superior structural aluminum alloy 6105-T5 for rail components

B. Regulatory Requirements:

1. Accessibility Requirements: In addition to requirements of authorities having jurisdiction, provide installed floor mats that comply with of ICC/ANSI A117.1-03.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver material to the project site ready for use and fabricated in as large sections and assemblies as practical, in unopened original factory packaging clearly labeled to identify manufacturer.

1. Identify products with appropriate markings of applicable testing and inspecting organization.
2. Deliver material to project site in manufacturer's original containers with original packing labels identifying material being supplied.
3. Storage: Store material delivered to Site off ground or floor slab and fully protected from damage, weather, and ground water at all times. Provide under cover at all times.
4. Protection from Deterioration: Do not allow materials to become wet or soiled, or covered with ice or snow. Comply with manufacturer's recommendations for handling, storage and protection during installation. Protect material from exposure to sunlight.
5. Protect insulation products from exposure to moisture.

1.6 PROJECT / SITE CONDITIONS

A. Field Measurements: Verify blocked-out openings in floors 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 floor mats and frames without field measurements. Coordinate floor construction to ensure that actual opening dimensions correspond to established dimensions.
 - a. Establish extent of existing concrete to be removed and the methods for removal of the existing concrete for placement of the floor mats and frames. Jackhammering and/or sawing of the existing concrete slab is allowed.

1.7 SEQUENCING AND SCHEDULING

A. Coordination

1. Coordinate size and location of oversized recesses in concrete work to receive floor mats and frames. Defer frame installations until building enclosure is completed and related interior finish work is in progress.
2. Coordinate integral installation of recessed frames and anchors with placing of concrete slab so frames are positioned accurately.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. As a Basis of Design details and specifications have been base on: Construction Specialties, Inc.
 1. **WOM1** - Roll-Up Entrance floor matt with recessed level base frame.
 - a. PediTred-Level Base Frame - "G4" – from C/S Group.
 2. Other Manufacturers that offer similar products and may be acceptable upon a compliance review include:
 - a. Balco, Inc.
 - b. Arden Architectural Specialties, Inc.
 - c. Or Approved Equal.

2.2 MATERIALS

A. Metal Frame:

1. Aluminum - ASTM B 221, alloy 6105-T5, 6105-T6 for extrusions; color / finish selected by Architect from full line of anodized aluminum finish options; minimum of (3) three selections.
2. Flexible and prime PVC extrusions.
3. Tread insert options - Carpet.

B. Concrete Fill and Grout Materials:

1. Provide concrete materials complying with Division 03 for grout and fill around and under recessed mats and frames that produce concrete equivalent in strength to cast-in-place concrete slabs. For concrete fill, adjust aggregate size to not exceed one-third fill thickness.

2.3 MANUFACTURED UNITS

- A. Floor Mats: Provide colors, patterns, and profiles of materials, including metals and metal finishes indicated or specified. If not indicated, provide colors, patterns, and profiles selected by Designer from manufacturer's standards.

Models and Descriptions:

1. "G4 PediTred" shall be extruded 6105-T5 aluminum alloy with ¾ inch deep tread rails joined by a dual durometer PVC combination hinge and cushion to compromise the overall grid length (traffic direction). The hinge shall be complete with perforations between each tread rail for drainage, unless otherwise specified. Unit must withstand 1000 lb. wheel loads (load applied to a 5" x2" wide polyurethane wheel, 1000 passes without damage).

- B. Recessed Matt Frames:

1. AL - Level Base Frame shall be a 1 inch (25.4mm) deep recessed frame in 6063-T6 aluminum alloy with anodized finish, with a ¼ inch wide exposed surface. Black vinyl fillers shall be furnished as required, when standard 1-1/2 inch tread spacing cannot be maintained. Installer shall use recommended latex screed to ensure level base.
 - a. Note: All out of view mill finish frames and pieces in contact with concrete to receive primer coating.

- C. Tread Insert Options:

1. HD Mono Tuft HD™ Carpet shall meet the Carpet and Rug Institute's standard for indoor air quality. Fibers shall include a minimum of 100, 12 mil monofilament fibers per square inch and colorfast, solution-dye nylon. Designer to select colors from 25 standard colors offered by the manufacturer. Each carpet fiber and monofilament shall be fusion-bonded to a rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths. Provide Anti-static carpet fiber containing antimicrobial additive and be treated with Scotchgard® to reduce soiling. Carpet weight shall be 33-oz/yd².

2.3 FABRICATION

- A. Shop Assembly: Verify sizes by field measurement before shop fabrication.

1. Floor Mats: Shop-fabricate units to greatest extent possible in sizes as indicated. If not otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Provide vinyl filler/edging as provided by manufacturer, cut to size in field.
2. Recessed Metal Mat Frames: Extruded aluminum bronze, of size and style to fit floor mat type specified, for permanent recessed installation, complete with corner pins or reinforcement and anchorage devices.

- a. Fabricate edge-frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.
 - b. Coat surfaces of aluminum frames that will contact cementitious material with manufacturer's standard protective coating.
- B. Finishing: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- 1. Aluminum Finishes: Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - a. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - 1) Color: As selected by Architect from full range of anodized aluminum colors and finishes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine conditions under which floor mats and frames are to be installed in coordination with Installer of materials and components specified in this Section and notify Contractor of any conditions detrimental to proper and timely installation. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to Installer.
- B. Examine substrates, floor conditions, and floor recesses for compliance with requirements for location, sizes, provide minimum recess depth required by manufacturer, and confirm other conditions affecting installation of floor mats and frames.

3.2 INSTALLATION

- A. Install recessed mat frames to comply with manufacturer's written instructions. Set mat tops at height recommended by manufacturer for most effective cleaning action; coordinate top of mat surfaces with bottom of doors that swing across mats to provide clearance between door and mat.
 - 1. Install necessary shims, spacers, and anchorages for proper location and secure attachment of frames.
 - 2. Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level.

- B. Set mat/grid at height recommended by manufacturer for most effective cleaning action.
- C. Coordinate top of mat/grid surfaces with bottom of doors that swing across to provide ample clearance between door and mat/grid.
- D. Set recessed mat frames at edge to align with top of final floor finish.

3.3 PROTECTION, CLEANING, DISPOSAL

- A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.
- B. Defer installation of floor mats until Project is near Substantial Completion.
- C. Dispose of all waste legally and in accordance with local jurisdictions requirements.
- D. Clean and adjust floor matt in accordance with manufacturer's cleaning requirements.
- E. Completely clean and vacuum installed units.

END OF SECTION

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Grout

1.2 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES:

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS:

- 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. CALPICO, Inc.
 2. Metraflex Company (The).
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 2. Pressure Plates: Plastic.
 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements

2.3 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION:

- A. Install sleeves for piping passing through penetrations in partitions and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete walls as new walls are constructed.
 1. Cut sleeves to length for mounting flush with both surfaces.
 2. Using grout, seal the space outside of sleeves in walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200, "Joint Sealants."

- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls and partitions at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413, "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION:

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE:

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

3.5 GROUT:

- A. Refer to Section 033000, "Cast in Place Concrete" for non-shrink grout.

END OF SECTION 210517

SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS:

- 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. Dearborn Brass
 2. Brasscraft Manufacturing
 3. One Stephens Corp
- B. One-Piece, Steel Type: With polished, chrome-plated polished brass finish and setscrew fastener.
- C. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- D. One-Piece, Cast-Brass Type: With polished, chrome-plated polished brass finish and setscrew fastener.
- E. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel brass with polished, chrome-plated finish and spring-clip fasteners.
- F. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

- G. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping and Relocated Existing Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Bare Piping at Wall Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated polished brass finish.
 - c. Bare Piping at Wall Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - d. Bare Piping at Wall Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated polished brass finish.
 - e. Bare Piping at Wall Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge or split-plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated polished brass finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - h. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated polished brass finish.
 - i. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge or split-plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.
 - j. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
 - k. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated rough-brass finish.
 - l. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge or split-plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.
 - m. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
 - n. Bare Piping in Equipment Rooms: One-piece cast brass with polished, chrome-plated rough-brass finish.

- o. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge or split-plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.
- 2. Escutcheons for Existing Piping to Remain:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - b. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - c. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
 - d. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons.

END OF SECTION 210518

SECTION 210548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe-riser resilient supports.
2. Resilient pipe guides.
3. Elastomeric hangers.
4. Spring hangers.
5. Snubbers.
6. Restraint channel bracings.
7. Restraint cables.
8. Seismic-restraint accessories.
9. Mechanical anchor bolts.
10. Adhesive anchor bolts.

B. Related Requirements:

1. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

1.2 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.3 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Shop Drawings:
 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.

- C. Product Data: For each type of product.
1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- D. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.
 3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
 4. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
 5. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

- c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for fire protection piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV.
 - a. Seismic Design Category. C.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second)(S_{DS}): 0.182.
4. Design Spectral Response Acceleration at 1.0-Second Period S_{DI} : 0.064.

2.2 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.
 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.3 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.
 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.4 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation
 - c. Novia; A Division of C&P
 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.

3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.5 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation
 - c. Novia; A Division of C&P
2. 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.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.6 SNUBBERS

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:

- a. Ace Mountings Co., Inc.
- b. California Dynamics Corporation
- c. Novia; A Division of C&P

- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

2.7 RESTRAINT CHANNEL BRACINGS

- 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. Hiti, Inc.
 2. Mason Industries, Inc.
 3. Unitrust; Port of Atkore International
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.8 RESTRAINT CABLES

- 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. Gripple Inc.
 2. Mason Industries, Inc.
 3. Novia; A Division of C&P
- B. Restraint Cables: ASTM A 603 galvanized ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.9 SEISMIC-RESTRAINT ACCESSORIES

- 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. Hilti, Inc.

2. Kinetics Noise Control
3. Mason Industries, Inc.

- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections Reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.10 MECHANICAL ANCHOR BOLTS

- 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. Hilti, Inc.
 2. Kinetics Noise Control
 3. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.11 ADHESIVE ANCHOR BOLTS

- 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. Hilti, Inc.
 2. Kinetics Noise Control
 3. Mason Industries, Inc.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior

applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Equipment Restraints:
 - 1. Install seismic snubbers on fire protection equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction that provides required submittals for component.

D. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

E. Install cables so they do not bend across edges of adjacent equipment or building structure.

F. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction that provides required submittals for component.

G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

H. 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.

I. 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.

J. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. 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 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211200 "Fire-Suppression Standpipes," Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211319 "Preaction Sprinkler Systems" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.

- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 210548

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Warning signs and labels.
 - 2. Pipe labels.
 - 3. Valve tags.
 - 4. Warning tags.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.
- C. Submit all manufacturers' technical data sheets to FM Global for review and comment.
- D. Samples: For color, letter style, and graphic representation required for each identification material and device.
- E. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- F. Valve Schedules: Valve numbering scheme.

1.3 CLOSEOUT SUBMITTALS:

- A. Maintenance Data: Include valve schedules for each piping system to include in the operation and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

PART 2 - PRODUCTS

2.1 PIPE LABELS

- 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. Emedco
 - 2. Kolbi Pipe Marker Co.
 - 3. LEM Products Inc.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
- F. Pipe-Label Colors:
 - 1. Background Color: Safety Red.
 - 2. Letter Color: White.

2.2 VALVE TAGS

- 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. Brimar Industries, Inc.
 - 2. Kolbi Pipe Marker Co
 - 3. Marking Service Inc.

- B. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: stainless steel, 0.025 inch thick, with predrilled holes for attachment hardware.
 - 2. Fasteners: Brass wire-link chain.
 - 3. Valve-Tag Color: Safety Red.
 - 4. Letter Color: White.

- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.3 WARNING TAGS

- 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. Brimar Industries, Inc.
 - 2. Kolbi Pipe Marker Co
 - 3. Marking Service Inc.

- B. Description: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Safety Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 PIPE LABEL INSTALLATION

- A. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near penetrations and on both sides of through walls, and inaccessible enclosures.
 - 3. At access doors, manholes, and similar access points that permit a view of concealed piping.
 - 4. Near major equipment items and other points of origination and termination.
 - 5. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 6. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
 - 1. Valve-Tag Size and Shape:
 - a. Wet-Pipe Sprinkler System: 2 inches, round square.
 - b. Pre-Action System: 2 inches, round square.
 - c. Clean-Agent Fire-Extinguishing System: 2 inches, round square.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 210553

SECTION 211200 - FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection specialty valves.
3. Hose connections.
4. Pressure gages.

B. Related Requirements:

1. Section 211313 "Wet-Pipe Sprinkler Systems" for wet-pipe sprinkler piping and valves.
2. Section 283100 "Fire Alarm System" for connections to alarm devices.

1.2 DEFINITIONS

- ##### A. Standard-Pressure Standpipe Piping: Fire-suppression standpipe piping designed to operate at working pressure 175 psig maximum.

1.3 ACTION SUBMITTALS

- ##### A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

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

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Working Drawings: For fire-suppression standpipes.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

- ##### D. Delegated-Design Submittal: For standpipe systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Fire-suppression standpipes, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Plumbing piping.
 - 2. Fire Protection piping
 - 3. Mechanical ductwork and piping
 - 4. Electrical conduits and raceways

The Contractor and each Installer shall approve (sign-off on) the Coordination Drawings prior to their submission.

- A. Qualification Data: For qualified Installer and professional engineer.
- B. Approved Standpipe Drawings: Working plans, prepared according to FM Global and NFPA 14, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- C. Welding certificates.
- D. Fire-hydrant flow test report.
- E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in FM Global and NFPA 14. Per FM Global requirements, include FM Global's "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."
- F. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing fire-suppression standpipes and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer. A minimum of 10 psi pressure cushion shall be provided between available water supply and system demand.

- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- 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. NFPA Standards: Fire-suppression standpipe equipment, specialties, accessories, installation, and testing shall comply with NFPA 14.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Fire-Suppression Standpipe Service: Coordinate service interruption with the Engineer in accordance with other Contract requirements.

PART 2 - PRODUCTS

- 2.1 All products in this specification shall be FM Global Approved. Refer to FM Global Data Sheets, including Data Sheet 2-0, for FM Global requirements.

2.2 SYSTEM DESCRIPTIONS

- A. Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

2.3 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure, Fire-Suppression Standpipe System Component: Listed for 175-psig minimum working pressure.
- A. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Available fire-hydrant flow test records indicate the following conditions:

- a. Date: November 20, 2017.
- b. Time: 1:00 p.m.
- c. Performed by: MDC
- d. Location of Residual Fire Hydrant R: #2640 Berlin Turnpike

- 1) Static Pressure at Residual Fire Hydrant R: 114 psig.
- 2) Residual Pressure at Residual Fire Hydrant R: 104 psig.

- e. Location of Flow Fire Hydrant F: #2688 Berlin Turnpike
 - 1) Pitot Pressure at Flow Fire Hydrant F: 90 psig.
 - 2) Measured Flow at Flow Fire Hydrant F: 1590 gpm.
- B. Fire-suppression standpipe design shall be approved by authorities having jurisdiction.
 - 1. Minimum residual pressure at each hose-connection outlet is as follows:
 - a. NPS 2-1/2 Hose Connections: 100 psig
- C. Seismic Performance: Fire-suppression standpipes shall withstand the effects of earthquake motions determined according to FM Global, NFPA 13 and ASCE/SEI 7.

2.4 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials and for joining methods for specific services, service locations, and pipe sizes.

2.5 BLACK STEEL PIPE AND ASSOCIATED FITTINGS

- A. Schedule 40: ASTM A 53/A 53M, Type E, Grade B; with factory- or field-formed ends to accommodate joining method.
- B. Uncoated, Steel Couplings: ASTM A 865/A 865M, threaded.
- C. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- D. Malleable- or Ductile-Iron Unions: FM GLOBAL 860.
- E. Cast-Iron Flanges: ASME B16.1, Class 125.
- F. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- G. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- H. Grooved-Joint, Steel-Pipe Appurtenances:
 - 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. Anvil International
 - b. Tyco Fire Products LP
 - c. Victaulic Company

2. Pressure Rating: 175 psig.
3. Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and FM GLOBAL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.6 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.
 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.7 SPECIALTY VALVES

- A. General Requirements:
 1. Standard: FM GLOBAL's "Fire Protection Equipment Directory" listing or FM Global's "Approval Guide."
 2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
 3. Body Material: Cast or ductile iron.
 4. Size: Same as connected piping.
 5. End Connections: Flanged or grooved.

2.8 HOSE CONNECTIONS

A. Nonadjustable-Valve Hose Connections:

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. Viking Corporation
 - b. Tyco Fire Products LP
 - c. NIBCO INC.
2. Standard: FM GLOBAL 668 hose valve for connecting fire hose.
3. Pressure Rating: 300 psig minimum.
4. Material: Brass or bronze.
5. Size: NPS 2-1/2 as indicated.
6. Inlet: Female pipe threads.
7. Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads according to NFPA 1963 and matching local fire-department threads.
8. Pattern: Angle or gate.
9. Finish: Polished chrome-plated.

2.9 PRESSURE GAGES

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. AMETEK, Inc.
 2. Ashcroft Inc.
 3. WIKA Instrument Corporation
- B. Standard: FM GLOBAL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gage Range: 0 to 250 psig.
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install system and all components per the more stringent requirements of FM Global Data Sheet 2-0, Connecticut State Building Code, Connecticut State Fire Code, NFPA 13 and NFPA 14 as adopted by the state of Connecticut.
- B. Final acceptance of system will be by field examination and satisfactory completion of FM Global's Contractor's Material and Test Certificate.

3.2 PREPARATION

- A. Perform fire-hydrant flow test according to FM Global, NFPA 14, and NFPA 291. Use results for system design calculations required in "Quality Assurance".
- B. Report test results promptly and in writing.

3.3 EXAMINATION

- A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.
- B. Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements in NFPA 14 and FM Global for installation of fire-suppression standpipe piping.
- C. Install seismic restraints on piping. Comply with requirements in NFPA 13 and FM Global for seismic-restraint device materials and installation.

- D. Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install drain valves on standpipes. Extend drain piping to outside of building.
- F. Install hangers and supports for standpipe system piping according to NFPA 14 and FM Global. Comply with requirements in NFPA 13 and FM Global for hanger materials.
- G. Install pressure gages on riser or feed main and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.
- H. Fill wet-type standpipe system piping with water.
- I. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- J. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- K. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.5 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- J. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- K. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- L. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.6 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 14, FM Global, and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

3.7 HOSE-CONNECTION INSTALLATION

- A. Install hose connections adjacent to standpipes.
- B. Install freestanding hose connections for access and minimum passage restriction.
- C. Install NPS 2-1/2 hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 reducer adapter and flow-restricting device.

3.8 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14 and FM Global.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter and FM Global.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Start and run air compressors.
 - 6. Coordinate with fire-alarm tests. Operate as required.
 - 7. Coordinate with fire-pump tests. Operate as required.
 - 8. Verify that equipment hose threads are same as local fire-department equipment.
- C. Fire-suppression standpipe system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.10 PIPING SCHEDULE

- A. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 4 and smaller, shall be one of the following:

1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- B. Standard-pressure, wet-type fire-suppression standpipe piping, NPS 5 to NPS 8 , shall be one of the following:
1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 3. Schedule 40 or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.

END OF SECTION 211200

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gages.

1.2 DEFINITIONS:

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.3 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
1. Include Sprinkler Identification Numbers (SIN).
 2. All components shall be FM Global Approved as currently listed in the FM Global Approval Guide. This is available at [www.FM Global.com](http://www.FMGlobal.com) and is listed as Volume 1, Chapter 1.
 3. Spare Parts: Include name, address, and telephone number of in-state supplier of spare parts. No out-of-state suppliers shall be permitted.
- C. Submit all manufacturers' technical data sheets and all FM Global required forms to FM Global for review and comment.
- D. Working Drawings: For wet-pipe sprinkler systems.
1. Include plans, elevations, sections, and attachment details.
 2. Include diagrams for power, signal, and control wiring.

- E. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

- F. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components indicating coordination with general construction, building components, mechanical systems, and other building services.
 - 2. Structural members to which elements of construction will be attached.
 - 3. Size and location of initial access modules for acoustical panels.
 - 4. Size and location of items penetrating finished ceilings including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings
 - 5. Ducts associated with HVAC systems.
 - 6. Penetrations of smoke barriers and fire-rated construction.
 - 7. Piping associated with HVAC, plumbing, and fire protection systems.
 - 8. Electrical conduits and cable trays.

The Contractor and each Installer shall approve (sign-off on) the Coordination Drawings prior to their submission.

- G. Quality Assurance Submittals:
 - 1. Qualification Data: Provide copies of licenses for qualified Installer and professional engineer.

- H. Approved Sprinkler Piping Drawings: Working plans, prepared according to according to the more restrictive recommendations of FM GLOBAL Data Sheet 2-0 and NFPA 13 that have been approved by authorities having jurisdiction, including hydraulic calculations.

- I. As a part of shop drawing submittal, stamped and signed calculations and shop drawings by a qualified professional engineer to be submitted to the local fire marshal and FM Global for review and approval prior to system installation.

- J. Welding certificates.

- K. Fire-hydrant flow test report.

- L. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in FM GLOBAL Data Sheet 2-0 and NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- M. Maintenance Data: For sprinkler specialties to include in operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 PERFORMANCE REQUIREMENTS:

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
 - 1. Stamped and signed drawings and calculations by qualified professional engineer
 - 2. Available fire-hydrant flow test records indicate the following conditions:
 - a. Date: November 20, 2017.
 - b. Time: 1:00 p.m.
 - c. Performed by: MDC
 - d. Location of Residual Fire Hydrant R: #2640 Berlin Turnpike
 - 1) Static Pressure at Residual Fire Hydrant R: 114 psig.
 - 2) Residual Pressure at Residual Fire Hydrant R: 104 psig.
 - e. Location of Flow Fire Hydrant F: #2688 Berlin Turnpike
 - 1) Pitot Pressure at Flow Fire Hydrant F: 90 psig.
 - 2) Measured Flow at Flow Fire Hydrant F: 1590 gpm.
- C. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: A minimum of 10 psi, or 10%, whichever is more stringent, safety margin shall be maintained between the available water supply and the combined demand of the sprinkler system and hose stream allowance.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Mechanical, Electrical, and Data Room: FM Hazard Category 2.
 - b. Office Areas: FM Hazard Category 1.

3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. FM Hazard Category 1: 0.10 gpm/sq. ft. over 1500-sq. ft. area, in accordance with FM GLOBAL Data Sheet 3-26.
 - b. FM Hazard Category 2: 0.20 gpm/sq. ft. over 2500-sq. ft. area, in accordance with FM GLOBAL Data Sheet 3-26.
 4. Maximum Protection Area per Sprinkler:
 - a. According to the more restrictive recommendations of FM GLOBAL Data Sheet 2-0 and NFPA 13, unless otherwise indicated.
 5. Total Combined Hose-Stream Demand Requirement: According to the more restrictive recommendations of FM GLOBAL Data Sheets 2-0, 3-26, 7-32, 8-3 and NFPA 13, unless otherwise indicated:
 - a. FM Hazard Category 1: 250 gpm.
 - b. FM Hazard Category 2: 250 gpm.
 6. Quick Response Sprinklers: FM Global does NOT subscribe to any Reduction in Area Methods associated with Quick-Response sprinklers.
- D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to the more restrictive recommendations of FM GLOBAL Data Sheet 2-0, 2-8, and NFPA 13, as well as ASCE/SEI 7.

1.5 QUALITY ASSURANCE:

- A. Installer Qualifications:
 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- 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. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following unless referenced FM Global Standards include more stringent requirements:

1. NFPA 13, "Installation of Sprinkler Systems."

E. FM Global Standards (available at www.FM Global.com):

1. Data Sheet 2-0, "Installation Guidelines for Automatic Sprinklers."
2. Data Sheet 2-8, "Earthquake Protection for Water-Based Fire Protection Systems."

1.6 COORDINATION:

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.7 SPARE PARTS:

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS

B. Furnish to the Engineer spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by the more restrictive of FM GLOBAL Data Sheet 2-0 and NFPA 13, and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Coordinate with owner for their requirements regarding when, prior to interruption of sprinkler service, owner should be notified. Notify Owner no sooner than this directed time frame in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Owner's written permission.

PART 2 - PRODUCTS

- 2.1 All products in this specification shall be FM Global Approved. Refer to FM Global Data Sheets, including Data Sheet 2-0, for FM Global requirements
- 2.2 PIPING MATERIALS:
- A. Comply with requirements in Part 3.12, "Piping Schedule" for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
- 2.3 STEEL PIPE AND FITTINGS:
- A. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Galvanized and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- C. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.
- D. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- E. Malleable- or Ductile-Iron Unions: UL 860.
- F. Cast-Iron Flanges: ASME 16.1, Class 125.
- G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- H. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- I. Grooved-Joint, Steel-Pipe Appurtenances:
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. Anvil International, Inc.
 - b. Shurjoint Piping Products.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 2. Pressure Rating: 175 psig minimum.

3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
- J. Steel Pressure-Seal Fittings: UL 213, FM-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.
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. Victaulic Company.

2.4 DUCTILE-IRON PIPE AND FITTINGS:

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
 2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.5 PIPING JOINING MATERIALS:

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.
1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.6 LISTED FIRE-PROTECTION VALVES:

A. General Requirements:

1. Valves shall be FM approved.
2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.

B. Ball Valves:

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. Anvil International, Inc.
 - b. Victaulic Company.
2. Standard: UL 1091 except with ball instead of disc.
3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.
4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
5. Valves NPS 3: Ductile-iron body with grooved ends.

C. Iron Butterfly Valves:

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. Anvil International, Inc.
 - b. Milwaukee Valve Company.
 - c. Victaulic Company.
2. Standard: UL 1091.
3. Pressure Rating: 175 psig.
4. Body Material: Cast or ductile iron.
5. Style: Lug or wafer.
6. End Connections: Grooved.

D. Check Valves:

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. AFAC Inc.
 - b. Anvil International, Inc.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Milwaukee Valve Company.

- e. NIBCO INC.
 - f. Victaulic Company.
2. Standard: UL 312.
 3. Pressure Rating: 250 psig minimum.
 4. Type: Swing check.
 5. Body Material: Cast iron.
 6. End Connections: Flanged or grooved.
- E. Iron OS&Y Gate Valves
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. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Shurjoint Piping Products.
 - e. Tyco Fire & Building Products LP.
 2. Standard: UL 262.
 3. Pressure Rating: 250 psig minimum.
 4. Body Material: Cast or ductile iron.
 5. End Connections: Flanged or grooved.
- F. Indicating-Type Butterfly Valves:
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. Anvil International, Inc.
 - b. Fivalco Inc.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Shurjoint Piping Products.
 - f. Tyco Fire & Building Products LP.
 - g. Victaulic Company.
 2. Standard: UL 1091.
 3. Pressure Rating: 175 psig minimum.
 4. Valves NPS 2 and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.

5. Valves NPS 2-1/2 and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
6. Valve Operation: Integral visual indicating device.

2.7 TRIM AND DRAIN VALVES:

A. General Requirements:

1. Standard: "Approval Guide," published by FM Global, listing.
2. Pressure Rating: 175 psig minimum.

B. Ball Valves:

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. Anvil International, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. Tyco Fire & Building Products LP.
 - e. Victaulic Company.

2.8 SPECIALTY VALVES:

A. General Requirements:

1. Standard: "Approval Guide," published by FM Global, listing.
2. Pressure Rating:
 - a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.
3. Body Material: Cast or ductile iron.
4. Size: Same as connected piping.
5. End Connections: Flanged or grooved.

B. Alarm Valves:

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. AFAC Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
2. Standard: UL 193.
 3. Design: For horizontal or vertical installation.
 4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber (if water supply pressure is not constant), and fill-line attachment with strainer.
 5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping if a retarding chamber is provided; otherwise pipe drain with check valve to main drain piping.

2.9 SPRINKLER SPECIALTY PIPE FITTINGS:

A. Branch Outlet Fittings:

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. Anvil International, Inc.
 - b. Shurjoint Piping Products.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
2. Standard: UL 213.
3. Pressure Rating: 175 psig minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

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. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
2. Standard: "Approval Guide," published by FM Global, listing.

3. Pressure Rating: 175 psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

C. Branch Line Testers:

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. Elkhart Brass Mfg. Company, Inc.
 - b. Fire-End & Croker Corporation.
 - c. Potter Roemer.
2. Standard: UL 199.
3. Pressure Rating: 175 psig.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

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. Tyco Fire & Building Products LP.
 - b. Victaulic Company.
 - c. Viking Corporation.
2. Standard: "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

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. CECA, LLC.
 - b. Merit Manufacturing; a division of Anvil International, Inc.

2. Standard: UL 1474.
3. Pressure Rating: 250 psig minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:

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. Fivalco Inc.
 - b. FlexHead Industries, Inc.
 - c. Gateway Tubing, Inc.
2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175 psig minimum.
5. Size: Same as connected piping, for sprinkler.

2.10 SPRINKLERS:

- 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. AFAC Inc.
 2. Reliable Automatic Sprinkler Co., Inc.
 3. Tyco Fire & Building Products LP.
 4. Victaulic Company.
 5. Viking Corporation.
- B. General Requirements:
 1. Standard: "Approval Guide," published by FM Global, listing.
 2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
 1. Nonresidential Applications: UL 199.
 2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6 unless otherwise indicated or required by application, Quick Response, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.

E. Special Coatings:

1. Wax.

F. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, two piece, with 1-inch vertical adjustment.

G. Sprinkler Guards:

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. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.11 ALARM DEVICES:

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

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. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Notifier; a Honeywell company.
 - c. Potter Electric Signal Company.
2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 10-inch diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.

C. Water-Flow Indicators:

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. Potter Electric Signal Company.
 - b. System Sensor; a Honeywell company.
 - c. Viking Corporation.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Pressure Switches:

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. AFAC Inc.
 - b. Potter Electric Signal Company.
 - c. System Sensor; a Honeywell company.
 - d. Tyco Fire & Building Products LP.
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

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. Fire-Lite Alarms, Inc.; a Honeywell company.
 - b. Kennedy Valve; a division of McWane, Inc.
 - c. Potter Electric Signal Company.
 - d. System Sensor; a Honeywell company.
2. Standard: UL 346.

3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

2.12 PRESSURE GAGES:

- 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. AMETEK; U.S. Gauge Division.
 2. Ashcroft, Inc.
 3. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gauge Range: 0 to 250 psig minimum.
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install system and all components per the more stringent requirements of FM Global Data Sheet 2-0, Connecticut State Building Code, Connecticut State Fire Code, and NFPA 13 as adopted by the state of Connecticut.
- B. Final acceptance of system will be by field examination and satisfactory completion of FM Global's Contractor's Material and Test Certificate.

3.2 PREPARATION:

- A. Perform fire-hydrant flow test according to the more restrictive recommendations of FM GLOBAL Data Sheet 2-0 and NFPA 13, and NFPA 291. Use results for system design calculations required in Part. 1.6, "Quality Assurance."
- B. Report test results promptly and in writing.

3.3 PIPING INSTALLATION:

- A. Locations and Arrangements: Plans indicate general location and arrangement of piping and sprinkler heads for illustrative purposes of required coverage only. The Contractor shall locate piping and sprinklers as required by its design.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Designer before deviating from approved working plans.
- B. Piping Standard: Comply with the more restrictive requirements for installation of sprinkler piping in FM GLOBAL Data Sheet 2-0 and NFPA 13.
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install seismic restraints on piping. Comply with the more restrictive requirements for seismic-restraint device materials and installation in FM GLOBAL Data Sheet 2-0, NFPA 13 and ASCE/SEI 7.
- E. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- F. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- G. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- H. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to the more restrictive requirements of FM GLOBAL Data Sheet 2-0 and NFPA 13.
- I. Install sprinkler piping with drains for complete system drainage.
- J. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- K. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- L. Install alarm devices in piping systems.
- M. Install hangers and supports for sprinkler system piping according to the more restrictive requirements of FM GLOBAL Data Sheet 2-0 and NFPA 13. Comply with the more restrictive requirements for hanger materials in FM GLOBAL Data Sheet 2-0 and NFPA 13.

- N. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft metal seated ball valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.
- O. Fill sprinkler system piping with water.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517, "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517, "Sleeves and Sleeve Seals for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION:

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to Part 1.6, "Quality Assurance."
 - 1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION:

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to the more restrictive requirements of FM GLOBAL Data Sheet 2-0 and NFPA 13, and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
- E. Do not install bypass piping around backflow preventers.

3.6 SPRINKLER INSTALLATION:

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.7 IDENTIFICATION:

- A. Install labeling and pipe markers on equipment and piping according to the more restrictive requirements of FM GLOBAL Data Sheet 2-0 and NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL:

- A. Perform tests and inspections in the presence of the Engineer, the authority having jurisdiction, and FM GLOBAL.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to FM GLOBAL Data Sheet 2-0 and NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 CLEANING:

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.10 TRAINING:

- A. Refer to Form 817 for additional information.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.11 PIPING SCHEDULE:

- A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- B. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- D. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:
 - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - 2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - 3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.12 SPRINKLER SCHEDULE:

- A. Use sprinkler types in subparagraphs below for the following applications:
 - 1. Rooms without Ceilings: Upright sprinklers.
 - 2. Rooms with Suspended Ceilings: Pendent sprinklers.
 - 3. Wall Mounting: Sidewall sprinklers.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
- C. Provide sprinkler guards for all sprinklers in the Mechanical Room, Electrical Room, Communications Room, and the Sprinkler Room.

END OF SECTION 211313

SECTION 211319 - PREACTION SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Specialty valves.
3. Sprinkler specialty pipe fittings.
4. Sprinklers.
5. Alarm devices.
6. Heat detectors.
7. Manual control stations.
8. Control panels.
9. Pressure gages.

B. Related Requirements:

1. Section 211313 "Wet-Pipe Sprinkler Systems" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.
2. Section 283100 "Fire Alarm System"

1.2 DEFINITIONS

- ##### A. Standard-Pressure Sprinkler Piping:
- Preaction sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.3 ACTION SUBMITTALS

- ##### A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- ##### B. Product Data:
- For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1. Include Sprinkler Identification Numbers (SIN).
2. All components shall be FM Approved as currently listed in the FM Global Approval Guide. This is available at www.fmglobal.com and is listed as Volume 1, Chapter 1.
3. Spare Parts: Include name, address, and telephone number of in-state supplier of spare parts. No out-of-state suppliers shall be permitted.

- C. Delegated-Design Submittal: For preaction sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Working Drawings: For preaction sprinkler systems.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.
- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components indicating coordination with general construction, building components, mechanical systems, and other building services.
 - 2. Structural members to which elements of construction will be attached.
 - 3. Size and location of initial access modules for acoustical panels.
 - 4. Size and location of items penetrating finished ceilings including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings
 - 5. Ducts associated with HVAC systems.
 - 6. Penetrations of smoke barriers and fire-rated construction.
 - 7. Piping associated with HVAC, plumbing, and fire protection systems.
 - 8. Electrical conduits and cable trays.

The Contractor and each Installer shall approve (sign-off on) the Coordination Drawings prior to their submission.

- B. Quality Assurance Submittals:
 - 1. Qualification Data: Provide copies of licenses for qualified Installer and professional engineer.
- C. Approved Sprinkler Piping Drawings: Working plans, prepared according to according to the more restrictive recommendations of FM Global Data Sheet 2-0, 2-10R, and NFPA 13 that have been approved by authorities having jurisdiction, including hydraulic calculations.
- D. Welding certificates.
- E. Fire-hydrant flow test report.

- F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in FM Global Data Sheet 2-0, 2-10R, and NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- G. Field quality-control reports.

1.4 PERFORMANCE REQUIREMENTS:

- A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- B. Delegated Design: Design sprinkler system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1. Available fire-hydrant flow test records indicate the following conditions:

- a. Date: November 20, 2017.
- b. Time: 1:00 p.m.
- c. Performed by: MDC
- d. Location of Residual Fire Hydrant R: #2640 Berlin Turnpike
 - 1) Static Pressure at Residual Fire Hydrant R: 114 psig.
 - 2) Residual Pressure at Residual Fire Hydrant R: 104 psig.
- e. Location of Flow Fire Hydrant F: #2688 Berlin Turnpike
 - 1) Pitot Pressure at Flow Fire Hydrant F: 90 psig.
 - 2) Measured Flow at Flow Fire Hydrant F: 1590 gpm.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

- 1. Margin of Safety for Available Water Flow and Pressure: A minimum of 10 psi, or 10%, whichever is more stringent, safety margin shall be maintained between the available water supply and the combined demand of the sprinkler system and hose stream allowance.
- 2. Sprinkler Occupancy Hazard Classifications:
 - a. Mechanical, Electrical, and Data Room: FM Hazard Category 2.
 - b. Office Areas: FM Hazard Category 1.
- 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. FM Hazard Category 1: 0.10 gpm/sq. ft. over 1500-sq. ft. area, in accordance with FMG Data Sheet 3-26.

- b. FM Hazard Category 2: 0.20 gpm/sq. ft. over 2500-sq. ft. area, in accordance with FMG Data Sheet 3-26.
 - 4. Maximum Protection Area per Sprinkler:
 - a. According to the more restrictive recommendations of FMG Data Sheet 2-0 and NFPA 13, unless otherwise indicated.
 - 5. Total Combined Hose-Stream Demand Requirement: According to the more restrictive recommendations of FMG Data Sheets 2-0, 3-26, 7-32, 8-3 and NFPA 13, unless otherwise indicated:
 - a. FM Hazard Category 1: 250 gpm.
 - b. FM Hazard Category 2: 250 gpm.
 - 6. Quick Response Sprinklers: FM Global does NOT subscribe to any Reduction in Area Methods associated with Quick-Response sprinklers.
 - D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to the more restrictive recommendations of FMG Data Sheet 2-0, 2-8, and NFPA 13, as well as ASCE/SEI 7.
- 1.5 QUALITY ASSURANCE:
- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
 - B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
 - 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. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following unless referenced FM Global Standards include more stringent requirements:
 - 1. NFPA 13, "Installation of Sprinkler Systems."
 - E. FM Global Standards (available at www.fmglobal.com):

1. Data Sheet 2-0, "Installation Guidelines for Automatic Sprinklers."
2. Data Sheet 2-8, "Earthquake Protection for Water-Based Fire Protection Systems."
3. Data Sheet 2-10R, "Dry-Pipe, Deluge, Preaction Valves & Accessories."
4. Data Sheet 5-32, "Data Centers and Related Facilities."

1.6 COORDINATION:

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.7 SPARE PARTS:

- A. Furnish to the Engineer spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by the more restrictive of FM Global Data Sheet 2-0 and NFPA 13, and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Coordinate service interruption with the Engineer in accordance with other Contract requirements.

PART 2 – PRODUCTS

- 2.1 All products in this specification shall be FM Global Approved. Refer to FM Global Data Sheets, including Data Sheets 2-0, 2-10R, and 5-32, for FM Global requirements.

2.2 SYSTEM DESCRIPTIONS

- A. Double-Interlock Preaction Sprinkler System: The Department has identified this as a system requirement even though it may be in conflict with FM Global Data Sheets.

B. Preaction Sequence of Operation

1. The activation of the heat detector
 - a. Illuminate appropriate zone lamp on control panel
 - b. Send an alarm signal to the building fire alarm system
 - c. Energize the solenoid valve
2. The fusing of a sprinkler head shall:
 - a. Relieve supervisory pressure from piping system, causing the pneumatic actuator to open
3. In order to trip the release circuit and allow water to enter the preaction system piping, two independent events must occur. The sprinkler piping must lose air pressure due to the operation of one or more heads which cause the low air pressure switch to trip, and the release panel must detect an alarm from an initiating device, such as a heat detector or a manual pull station.
4. The activation of the water flow switch shall:
 - a. Illuminate appropriate supervisory lamp on control panel.
 - b. Send a supervisory signal to the building fire alarm system
5. Any system trouble condition shall
 - a. Illuminate appropriate supervisory lamp on control panel.
 - b. Send a supervisory signal to the building fire alarm system

2.3 PERFORMANCE REQUIREMENTS

- A. Preaction sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the more stringent requirements of the following:
 1. NFPA 13.
 2. FM Global Data Sheets
- B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- C. Delegated Design: Engage a qualified professional engineer to design preaction sprinkler systems.
- D. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
 2. Sprinkler Occupancy Hazard Classifications: Refer to FM Global Data Sheet 3-26
 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Hazard Category HC-1: 0.1 gpm over 1500-sq. ft. area.
 - b. Hazard Category HC-2: 0.2 gpm over 2500-sq. ft. area.
 4. Maximum Protection Area per Sprinkler: Refer to FM Global Data Sheet 2-0
 5. Total Combined Hose-Stream Demand Requirement: According to FM Global Data Sheet 3-26
- E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to FM Global Data Sheet 3-26

2.4 STEEL PIPE AND FITTINGS

- A. Standard-Weight, Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Steel piping shall be Schedule 40 for sizes less than 3 inches, and schedule 10 for sizes 3 inches and larger. Pipe ends may be factory or field formed to match joining method. Fittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples are threaded shall be welded, threaded, or grooved end type. Plain end fittings with mechanical couplings and fittings which use steel gripping devices to bite into the pipe when pressure is applied will not be permitted. Rubber gasketed grooved end pipe and fittings with mechanical couplings shall be permitted in pipe sizes 1.5 inches and larger. Fittings shall be FM APP GUIDE approved for use in preaction pipe sprinkler systems. Fittings, mechanical couplings, and rubber gaskets shall be supplied from the same manufacturer. Steel piping with wall thickness less than Schedule 30 shall not be threaded. Steel piping shall be galvanized.

2.5 LISTED FIRE PROTECTION VALVES:

- A. Control Valve and Gate Valve: Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in FM Global's "Approval Guide."
- B. Check Valve: Check valve 2 inches and larger shall be listed in FM Global's "Approval Guide." Check Valves 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4

2.6 LISTED PREACTION VALVE ASSEMBLY:

- A. Valves shall be operated by a detection system listed for releasing service and independent of building fire alarm system. Preaction valve clappers shall incorporate a latching mechanism that will not be affected by pressure changes in the water system. In addition to automatic operation, arrange each valve for manual release at the valve. Provide pressure gauges and other appurtenances at the preaction valves. Provide a test detection device for each actuation circuit adjacent to each valve which the device controls, as required by the more stringent requirements of NFPA 13 and FM Global.
 - 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. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.

2.7 SUPERVISORY AIR SYSTEM:

- A. General Requirements: Provide an air supply system in accordance with NFPA 13. The connection pipe from the air compressor shall not be less than 1/2 inch in diameter and shall enter the system above the priming water level of the preaction valve. Install a check valve in the system supply air piping from the compressor. A shutoff valve of the renewable disc type shall be installed upstream of this check valve.
- B. Air Compressor: Compressor shall be single stage oil-free type, air cooled, electric-motor driven, equipped with a check valve, shutoff valve and pressure switch for automatic starting and stopping. Pressure switch shall be factory set to start the compressor at 10 psi and stop it at 20 psi. A safety relief valve, set to operate at 65 psi, shall be provided.
- C. Air Pressure Maintenance Device: Device shall be a pressure regulator that automatically reduces supply air to provide the pressure required to be maintained in the piping system. The device shall have a cast bronze body and valve housing complete with diaphragm assembly, spring, filter, ball check to prevent backflow, 1/16 inch restriction to prevent rapid pressurization of the system, and adjustment screw. The device shall be capable of reducing an inlet pressure of up to 100 psig to a fixed outlet pressure adjustable to 10 psig. The device shall be listed for fire protection uses.
- D. Air Supply Piping System: Each preaction system shall be equipped with a separate pressure maintenance device, shutoff valve, bypass valve, and pressure gauge. Piping shall be galvanized steel in accordance with ASTM A795/A795M or ASTM A53/A53M
- E. Low Air Pressure Switch: Each preaction system shall be provided with an air pressure switch connected to the control panel. Upon reduction of supervisory air pressure to

approximately 10 psi, the low air pressure switch shall actuate the audible alarm device and a red low-air alarm light on the control panel.

2.8 CONTROL PANEL

- A. The control system shall meet the requirements of NFPA 72. The control panel shall be listed in FM Global's "Approval Guide". The control panel and the solenoid valve that activated the water control valves shall be compatible with each other. Compatibility shall be in accordance with FM approval of the control equipment. Panel shall contain all components and equipment required to provide the specified operational and supervisory functions of the system. House components in a surface or flush mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered and orderly factory assembled and wired unit. Panel shall include integral "power on," "alarm," and "trouble" lamps with annunciation of each alarm, supervisory and trouble signal. The panel shall have prominent rigid plastic or metal identification plates for lamps, zones, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. Control panel switches shall be within the locked cabinet. Provide a suitable means for testing the working condition and accuracy of the control panel visual indicating devices (meter and lamps). Meters and lamps shall be plainly visible when the cabinet door is closed. Signals shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Control panel shall be interfaced with the building fire alarm system and transfer all signals. Required building notification shall be by the building fire alarm system.
- B. Connect alarm initiating devices to initiating device circuits (IDC), Class X in accordance with NFPA 72. Provide a separate circuit for actuation of each individual automatic water control valve. Fully supervise the circuits that actuate the water control valves so that the occurrence of a single open or a single ground fault condition in the interconnecting conductors will be indicated at the control panel and building FACP.

2.9 POWER

- A. Primary Power Supply: Provide the primary operating power from two single-phase 120 VAC circuits. Transfer from normal to backup power and restoration from backup to normal power shall be fully automatic and shall not initiate a false alarm. Loss of primary power shall not prevent actuation of the respective automatic water control valve upon activation of any alarm initiating device. Primary power and trouble alarm power to the Control Panel shall be supplied from two 120 VAC circuits.
- B. Emergency Power Supply: Emergency power shall be provided for system operation in the event of failure of the primary power supply and shall consist of rechargeable storage battery system. Transfer from normal to emergency power or restoration from

emergency to normal power shall be automatic and shall not cause transmission of a false alarm.

- C. **Storage Batteries:** Storage Batteries shall be sealed, lead-calcium type requiring no additional water. Submit calculations to substantiate the total requirements for supervisory and alarm power. Include ampere-hour requirements for each system component and each control panel component or module, under both normal and alarm conditions. The battery recharging period shall be included with the calculations. The batteries shall have ample capacity, with primary power disconnected, to operate the system for a period of 90 hours. Following this period of operation via batteries, the batteries shall have ample capacity to operate all alarm indicating devices in the alarm mode for a minimum period of 60 minutes. Battery cabinet shall be a separate compartment at the bottom of the control panel or cabinet located adjacent to control panel. The battery cabinet shall have adequate space for spare duplicate storage batteries. Batteries shall be mounted on a noncorrosive and nonconductive base or pad.
- D. **Battery Charger:** Battery charge shall be completely automatic, with high/low charging rate, capable of restoring the batteries from full discharge to full charge within 12 hours using the high charging rate. A separate ammeter shall be provided for indicating rate of charge. A separate voltmeter shall be provided to indicate the state of the battery charge. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly. The charge shall be located in control panel cabinet.

2.10 ALARM INITIATING AND SUPERVISORY DEVICES

- A. **Sprinkler Pressure (Waterflow) Alarm Switch:** Pressure switch shall include a metal housing with a neoprene diaphragm, SPDT snap action switches and a 1/2 inch NPT male pipe thread. The switch shall have a maximum service pressure rating of 175 psi. There shall be two SPDT (Form C) contacts factory adjusted to operate at 4 to 8 psi. The switch shall be capable of being mounted in any position in the alarm line trim piping of the preaction valve
- B. **High/Low Air Pressure Supervisory Switch:** The low air pressure switch shall supervise the air pressure in the system and shall be set to activate at 10 psi (50% of the maintenance air pressure setting). The switch shall have an adjustable range between 5 and 40 psi. The switch shall have screw terminal connection and shall be capable of being wired for normally open or normally closed circuit. The high air pressure switch shall supervise the air pressure in the system and shall be set to activate at 2 times the maintenance air pressure setting.
- C. **Valve Supervisory (Tamper) Switch:** Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem.

2.11 SPRINKLER PIPING SPECIALTIES

- A. General Requirements for Preaction System Fittings: FM Global for preaction-pipe service.
- B. Branch Outlet Fittings:
 - 1. Standard: FM Global's "Approval Guide."
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 - 4. Type: Mechanical-tee and -cross fittings.
 - 5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
 - 6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 - 7. Branch Outlets: Grooved, plain-end pipe, or threaded.
- C. Flow Detection and Test Assemblies:
 - 1. Standard: FM Global's "Approval Guide."
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
 - 4. Size: Same as connected piping.
 - 5. Inlet and Outlet: Threaded.
- D. Branch Line Testers:
 - 1. Standard: FM Global's "Approval Guide."
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Body Material: Brass.
 - 4. Size: Same as connected piping.
 - 5. Inlet: Threaded.
 - 6. Drain Outlet: Threaded and capped.
 - 7. Branch Outlet: Threaded, for sprinkler.
- E. Sprinkler Inspector's Test Fittings:
 - 1. Standard: FM Global's "Approval Guide."
 - 2. Pressure Rating: 175-psig minimum.
 - 3. Body Material: Cast- or ductile-iron housing with sight glass.
 - 4. Size: Same as connected piping.
 - 5. Inlet and Outlet: Threaded.
- F. Adjustable Drop Nipples:
 - 1. Standard: FM Global's "Approval Guide."
 - 2. Pressure Rating: 250-psig minimum.
 - 3. Body Material: Steel pipe with EPDM O-ring seals.

4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

2.12 SPRINKLERS

- A. Listed in FM Global's "Approval Guide."
- B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- C. Automatic Sprinklers with Heat-Responsive Element:
 1. Nonresidential Applications: FM 2031.
 2. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, Quick Response, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application. Use sprinkler types in subparagraphs below for the following applications:
 - a. Rooms without Ceilings: Upright sprinklers.
 - b. Rooms with Suspended Ceilings: Dry pendent sprinklers.
- D. Provide sprinkler types in subparagraphs below with finishes indicated.
 1. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 2. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 3. Upright and Pendent, Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
- E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 1. Ceiling Mounting: Chrome-plated steel, one piece, flat
- F. Sprinkler Guards:
 1. Standard: FM Global's "Approval Guide."
 2. Type: Wire cage with fastening device for attaching to sprinkler.

2.13 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Motor-Operated Alarm:

1. Standard: FM Global's "Approval Guide."
2. Type: Mechanically operated, with Pelton wheel.
3. Alarm Gong: Cast aluminum with red-enamel factory finish.
4. Size: 10-inch diameter.
5. Components: Shaft length, bearings, and sleeve to suit wall construction.
6. Inlet: NPS 3/4.
7. Outlet: NPS 1 drain connection.

C. Electrically Operated Alarm Bell:

1. Standard: FM Global's "Approval Guide."
2. Type: Vibrating, metal alarm bell.
3. Finish: Red-enamel factory finish, suitable for outdoor use.
4. 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. Pressure Switches:

1. Standard: FM Global's "Approval Guide."
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

1. Standard: FM Global's "Approval Guide."
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. 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

2.14 HEAT DETECTORS

- A. Detectors shall be FM Global approved, heat sensitive, normally closed, electrical detectors which operate at a fixed temperature of 140°F. Detectors shall be rate compensating and feature automatic recycling. Detectors shall be connected in series from and to the control panel. When a detector is heated to the temperature set point, a mechanical switch shall open and break the series circuit interrupting the flow of current. When the temperature drops below the set point, the circuit shall be reestablished.
- B. Detectors shall be located and spaced per the more restrictive requirements of FM Global and NFPA 72. Detectors shall be coordinated with locations of light fixtures, grills, speakers, smoke detectors, and other ceiling mounted devices.

- C. Detectors in finished ceiling areas shall be installed using through ceiling mounting.

2.15 MANUAL CONTROL STATIONS

- A. Listed in FM Global's "Approval Guide" for hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve.
- B. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.16 CONTROL PANELS

- A. Description: Single-area, two-area, or single-area cross-zoned type control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves.
 - 1. Listed in FM Global's "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.
 - 2. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.
 - 3. 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. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- C. Manual Control Stations: Hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- D. Panels Components:
 - 1. Power supply.
 - 2. Battery charger.
 - 3. Standby batteries.
 - 4. Field-wiring terminal strip.
 - 5. Electrically supervised solenoid valves and polarized fire-alarm bell.
 - 6. Lamp test facility.
 - 7. Single-pole, double-throw auxiliary alarm contacts.
 - 8. Rectifier.

2.17 PRESSURE GAGES

- A. Standard: FM Global's "Approval Guide."
- B. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- C. Pressure Gage Range: 0- to 250-psig minimum.
- D. Label: Include "WATER" or "AIR/WATER" label on dial face.
- E. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install system and all components per the more stringent requirements of FM Global Data Sheet 2-0, 5-32, Connecticut State Building Code, Connecticut State Fire Code, NFPA 13 and NFPA 14 as adopted by the state of Connecticut.
- B. Final acceptance of system will be by field examination and satisfactory completion of FM Global's Contractor's Material and Test Certificate.

3.2 PREPARATION

- A. Perform fire-hydrant flow test according to the more stringent requirements of FM Global, NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

- B. Piping Standard: Comply with FM Global and NFPA 13 requirements for installation of sprinkler piping. When FM Global and NFPA 13 requirements conflict, the more stringent requirements shall be followed.
- C. Install seismic restraints on piping. Comply with FM Global and NFPA 13 requirements for seismic-restraint device materials and installation. When FM Global and NFPA 13 requirements conflict, the more stringent requirements shall be followed.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to FM Global and NFPA 13. When FM Global and NFPA 13 requirements conflict, the more stringent requirements shall be followed.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valves to drain piping between fire department connections and check valves. Drain to floor drain or to outside building.
- K. Connect compressed-air supply to preaction sprinkler piping.
- L. Connect air compressor to the following piping and wiring:
 - 1. Pressure gages and controls.
 - 2. Electrical power system.
 - 3. Fire-alarm devices, including low-pressure alarm.
- M. Install alarm devices in piping systems.
- N. Install hangers and supports for sprinkler system piping according to FM Global and NFPA 13. Comply with requirements in FM Global and NFPA 13. When FM Global and NFPA 13 requirements conflict, the more stringent requirements shall be followed. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
- O. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

- P. Drain preaction sprinkler piping.
- Q. Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices/ air compressors.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- K. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2104. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- L. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to the more stringent requirements of FM Global, NFPA 13, and according to the authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install preaction valves with trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.
 - a. Install air compressor and compressed-air-supply piping.
 - b. Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig adjustable range; and 175-psig maximum inlet pressure.
 - c. Install compressed-air-supply piping from building's compressed-air piping system.

3.6 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.
- B. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.7 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to the more stringent requirements of FM Global and NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Start and run air compressors.
 - 6. Coordinate with fire-alarm tests. Operate as required.
 - 7. Coordinate with fire-pump tests. Operate as required.
 - 8. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.10 PIPING SCHEDULE

- A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- B. Standard-pressure, preaction-pipe sprinkler system, NPS 2 and smaller, shall be:
 - 1. Standard-weight, Schedule 40 galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
- C. Standard-pressure, preaction-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be:
 - 1. Standard-weight, Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.

END OF SECTION 211319

SECTION 212200 - CLEAN-AGENT FIRE-EXTINGUISHING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Clean-agent systems.
2. Pipe and fittings.
3. Valves.
4. Extinguishing-agent containers.
5. Fire-extinguishing clean agent.
6. Discharge nozzles.
7. Manifold and orifice unions.
8. Fire control panels.
9. Detection devices.
10. Manual stations.
11. Switches.
12. Alarm devices.
13. Form 2332, Contractor's Application for Acceptance of Gas System

1.2 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. EPO: Emergency Power Off.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- C. Submit all manufacturers' technical data sheets and all FM Global required forms to FM Global for review and comment.
- D. Submit to FM Global form 2332, Contractor's Application for Acceptance of Gas System. Form is included at end of this specification.
- E. Sustainable Design Submittals

- F. Working Drawings: For clean-agent fire-extinguishing system signed and sealed by a qualified professional engineer.
1. Include plans, elevations, sections, details, and attachments to other work.
 2. Include design calculations.
 3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 4. Wiring Diagrams: For power, signal, and control wiring.
- G. Delegated-Design Submittal: For clean-agent fire-extinguishing system signed and sealed by the qualified professional engineer.
1. Indicate compliance with performance requirements and design criteria, including analysis data.
 2. Comply with the requirements illustrated in FM Global Property Loss Prevention Data Sheets 4-0, 4-9, 5-8, and Manufacturer Operations Manuals listed in FM Global's Approval Guide Listing.
 3. Include design calculations for weight, volume, and concentration of extinguishing agent required for each hazard area.
 4. Indicate the Following on Reflected Ceiling Plans:
 - a. Ceiling penetrations and ceiling-mounted items.
 - b. Extinguishing-agent containers if mounted above floor, piping and discharge nozzles, detectors, and accessories.
 - c. Method of attaching hangers to building structure.
 - d. Other ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, and access panels.
 5. Indicate the Following on Occupied Work Area Plans:
 - a. Controls and alarms.
 - b. Extinguishing-agent containers, piping and discharge nozzles if mounted in space, detectors, and accessories.
 - c. Equipment and furnishings.
 6. Indicate the Following on Access Floor Space Plans:
 - a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
 - b. Method of supporting piping.
 7. Indicate the Following on Ceiling Plans:
 - a. Extinguishing-agent containers, piping and discharge nozzles, detectors, and accessories.
 - b. Method of supporting piping.

- c. Other equipment located in the ceiling space that is being protected including sprinkler piping, HVAC equipment, raceways, or conduit.
- H. As a part of shop drawing submittal, stamped and signed calculations and shop drawings by a qualified professional engineer to be submitted to the local fire marshal and FM Global for review and approval prior to system installation.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Clean agent systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Piping.
2. Ductwork
3. Conduits and raceways
4. Sprinkler heads
5. Equipment
6. Detection devices
7. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Alarm devices
 - d. Speakers.
 - e. Fire Alarm System Smoke and Heat Detectors.
 - f. Occupancy Sensors.

- B. Design Data:

1. Permit Approved Drawings: Working plans, prepared according to Connecticut State Fire Code, Connecticut State Building Code, NFPA 2001 as adopted by the state of Connecticut, that have been approved by authorities having jurisdiction. Include design calculations.
2. Drawings and design shall be prepared according to the more stringent requirements of FM Global, the Connecticut State Fire Code, Connecticut State Building Code, and NFPA 2001 as adopted by the state of Connecticut

- C. Seismic Qualification Data: Certificates, for extinguishing-agent containers and control panels from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For special agent system to include in emergency, operation, and maintenance manuals.

1.6 SPARE PARTS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- B. Furnish spare parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.

1. Detection Devices: Not less than 20 percent of amount of each type installed.
2. Container Valves: Not less than 10 percent of amount of each size and type installed.
3. Nozzles: Not less than 20 percent of amount of each type installed.
4. Extinguishing Agent: Not less than 100 percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. FM Global Compliance: Provide components that are FM Approved and that are listed in FM Global's "Approval Guide."

PART 2 - PRODUCTS

2.1 All products in this specification shall be FM Global Approved. Refer to FM Global Data Sheets, including Data Sheets 4-9 and 5-32 for FM Global requirements.

2.2 CLEAN-AGENT SYSTEMS

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 followings:

1. Fike Corporation
2. Pyro-Chem; Tyco Fire Supply
3. Siemens Building Technologies
4. Approved equal

B. Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity above the ceiling, below the ceiling, and below the raised floor. System includes separate zones above and below the ceiling and beneath the raised floor. If smoke is detected below the raised floor, extinguishing agent shall be discharged in the underfloor zone only. If smoke is detected below the ceiling, extinguishing agent shall be discharged in zones above and below the ceiling and below the floor. If smoke is detected above the ceiling, extinguishing agent shall be discharged in the zone above the ceiling only.

C. Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, and C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.

D. Performance Requirements: Discharge HFC 227ea within 10 seconds and maintain 7.1 percent concentration by volume at 70 deg F for 10-minute holding time in hazard areas.

1. HFC 227ea concentration in hazard areas greater than 9.0 percent immediately after discharge or less than 5.8 percent throughout holding time will not be accepted without written authorization from Owner and authorities having jurisdiction.
2. System Capabilities: Minimum 620-psig calculated working pressure and 360-psig initial charging pressure.

E. Cross-Zoned Detection: Devices located in two separate zones. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating single-detection device in other zone.

- F. Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.
- G. System Operating Sequence:
 - 1. Actuating First Detector: Visual indication on annunciator panel. Energize audible and visual alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire-alarm system.
 - 2. Actuating Second Detector: Visual indication on annunciator panel. Energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 30 seconds, and discharge extinguishing agent. Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area.
- H. System Operating Sequence: System shall be cross-zoned, air-sampling detectors and photoelectric detectors reporting to a fully programmable microprocessor-based control panel programmed to operate as follows:
 - 1. If one photoelectric detector and air-sampling detector reaches the third detection level (Fire 1), agent discharge will be initiated as described for the third detection level (Fire 1) below.
 - 2. Air-Sampling System:
 - a. First Detection Level (Alert): Mild audible and visual indication on annunciator panel. Strobe lights flash slowly in the protected area.
 - b. Second Detection Level (Action): Strong audible and visual indication on annunciator panel. Strobe lights flash rapidly in the protected area.
 - c. Third Detection Level (Fire 1): Strong audible and visual indication on annunciator panel. Energize horn(s), bell(s), and strobe light(s) in the protected area and outside entry doors. Shut down air-conditioning and ventilating systems serving the protected area, and close doors in the protected area. Send signal to fire-alarm system, initiate 30-second time delay for extinguishing-agent discharge, and discharge extinguishing agent. At agent discharge, terminate power to equipment in the protected area.
- I. Manual stations shall immediately discharge extinguishing agent when activated.
- J. Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release of hand pressure on the switch will cause agent discharge if the time delay has expired.
- K. EPO: Will terminate power to protected equipment immediately on actuation.
- L. Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.
- M. Power Transfer Switch: Transfer from normal to stand-by power source.

- N. Seismic Performance: Fire-suppression piping and containers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.3 PIPE AND FITTINGS

- A. See "HFC 227ea Agent Piping Applications" for applications of pipe, tube, fitting, and joining materials.
- B. Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.
- C. Steel Pipe: ASTM A 53/A 53M, Type S, Grade B or ASTM A 106/A 106M, Grade A and Grade B; Schedule 40, Schedule 80, and Schedule 160, seamless steel pipe.
1. Threaded Fittings:
 - a. Malleable-Iron Fittings: ASME B16.3, Class 300.
 - b. Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
 - c. Fittings Working Pressure: 620 psig minimum.
 - d. Flanged Joints: Class 300 minimum.
 2. Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
 3. Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A 47/A 47M malleable iron or ASTM A 536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.
- D. 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.
- E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.
- F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Steel, Keyed Couplings: FM Global, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

2.4 VALVES

- A. General Valve Requirements:
 - 1. FM Global Approved for use in fire-protection systems.
 - 2. Compatible with type of clean agent used.
- B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.
- C. Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.
- D. Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

2.5 EXTINGUISHING-AGENT CONTAINERS

- A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.
 - 1. Finish: Red Manufacturer's standard color, enamel or epoxy paint.
 - 2. Manifold: Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
 - 3. Manifold: Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.
 - 4. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

2.6 FIRE-EXTINGUISHING CLEAN AGENT

- A. HFC 227ea Clean Agent: Heptafluoropropane.
 - 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. Dupont
 - b. Great Lakes Chemical Corporation

2.7 DISCHARGE NOZZLES

- 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. Ansul Incorporation
 2. Chemetron Fire System
- B. Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.
- C. Material: Corrosion-resistant metal.
- D. Stamped with orifice size and type.

2.8 MANIFOLD AND ORIFICE UNIONS

- A. Description: FM Approved and NRTL-listed device with minimum 2175-psig pressure rating, to control flow and reduce pressure of IG-541 gas in piping.
1. NPS 2 and Smaller: Piping assembly with orifice, sized for system design requirements.
 2. NPS 2-1/2 and Larger: Piping assembly with nipple, sized for system design requirements.

2.9 FIRE CONTROL PANELS

- 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:
- Ansul Incorporation
 - Chemetron Fire System
 - Approved equal
- B. Description: FM Approved and NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
- C. Power Requirements: 120/240-V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.
- D. Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
1. Mounting: Recessed flush with surface.
- E. Supervised Circuits: Separate circuits for each independent hazard area.
1. Detection circuits equal to the required number of zones, or addressable devices assigned to the required number of zones.
 2. Manual pull-station circuit.
 3. Alarm circuit.

4. Release circuit.
5. Abort circuit.
6. EPO circuit.

F. Control-Panel Features:

1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
2. Automatic switchover to standby power at loss of primary power.
3. Storage container, low-pressure indicator.
4. Service disconnects to interrupt system operation for maintenance with visual status indication on the annunciator panel.

G. Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless-steel or aluminum enclosure.

H. Standby Power: Sealed lead calcium Sealed, valve-regulated, recombinant lead acid Vented, wet-cell pocket, plate nickel cadmium batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

2.10 DETECTION DEVICES

A. General Requirements for Detection Devices:

1. Comply with NFPA 2001, NFPA 72, and FM Global requirements.
2. 24-V dc, nominal.

B. Photoelectric Detectors: LED light source and silicon photodiode receiving element.

C. Remote Air-Sampling Detector System: Includes air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.

1. Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
2. Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
3. Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 0.05-inch wg at all sampling ports.
4. Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.

- D. Signals to the Central Fire Alarm Control Panel: Any type of local system trouble is reported to the central fire alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to the central fire alarm control panel as separately identified zones.

2.11 MANUAL STATIONS

- A. General Description: Surface Semirecessed FM Approved and NRTL listed, with clear plastic hinged cover, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
- B. Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.
- C. Abort Switch: "ABORT" caption, momentary contact, with green finish.
- D. EPO Switch: "EPO" caption, with yellow finish.

2.12 SWITCHES

- A. Description: FM Approved and NRTL listed, where available, 120-V ac or low voltage compatible with controls. Include contacts for connection to control panel.
 - 1. Low-Agent Pressure Switches: Pneumatic operation.
 - 2. Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
 - 3. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

2.13 ALARM DEVICES

- A. Description: Listed and labeled by an NRTL listed and FM Approved, low voltage, and surface mounting. Comply with requirements in Section 283100 "Fire Alarm System."
- B. Bells: Minimum 6-inch diameter.
- C. Horns: 90 to 94 dBA.
- D. Strobe Lights: Translucent lens, with "FIRE" or similar caption.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install system and all components per the more stringent requirements of FM Global Data Sheet 4-9 and 5-32, Connecticut State Building Code, Connecticut State Fire Code, and NFPA 2001 as adopted by the state of Connecticut.

3.2 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting work performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Final acceptance of Clean Agent system will be subject to a field inspection by FM Global.

3.3 HFC 227ea AGENT PIPING APPLICATIONS

- A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
- B. NPS 2 and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.
- C. NPS 2-1/2 and Larger: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints steel.

3.4 CLEAN-AGENT PIPING INSTALLATION

- A. Install clean-agent extinguishing piping and other components level and plumb, according to manufacturers' written instructions.
- B. Grooved Piping Joints: Groove pipe ends according to AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant according to manufacturer's written instructions.
- C. Install extinguishing-agent containers anchored to substrate.
- D. Install pipe and fittings, valves, and discharge nozzles according to requirements listed in NFPA 2001 and FM Global Requirements

1. Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
2. Support piping using supports and methods according to NFPA 13.
3. Install seismic restraints for extinguishing-agent containers and piping systems.
4. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.
- C. Connect electrical devices to control panel and to building's fire-alarm system. Electrical power, wiring, and devices are specified in Section 283100 "Fire Alarm System."

3.6 IDENTIFICATION

- A. Identify system components and equipment. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify piping, extinguishing-agent containers, other equipment, and panels according to NFPA 2001.
- C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.
- D. Install signs at entry doors to advise persons outside the room the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.
 1. Testing shall adhere to the more stringent requirements of FM Global, Connecticut State Fire Code, Connecticut State Building Code, and NFPA 2001 as adopted by the state of Connecticut
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. 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.

D. Tests and Inspections:

1. Inspect and test clean agent system in accordance with the more stringent requirements of FM Global data sheet 4-9, Connecticut State Building and Fire Codes, and NFPA 2001 as adopted by the state of Connecticut
2. After installing clean-agent extinguishing piping system and after electrical circuitry has been energized, test for compliance with requirements.
3. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections "Inspection and Test Procedures" and "System Function Tests." Certify compliance with test parameters.
4. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
5. Conduct enclosure integrity procedure of the protected occupancy in accordance with Appendix C of NFPA 2001 as adopted by the state of Connecticut. An enclosure integrity procedure in accordance with Annex E of ISO 14520 is an acceptable alternative.
6. Maintain agent design concentration within the protected enclosure for a minimum of 10 minutes.
7. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
8. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 CLEANING

- A. Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

3.9 SYSTEM FILLING

A. Preparation:

1. Verify that piping system installation is completed and cleaned.
2. Check for complete enclosure integrity.
3. Check operation of ventilation and exhaust systems.

B. Filling Procedures:

1. Fill extinguishing-agent containers with extinguishing agent, and pressurize to indicated charging pressure.
2. Install filled extinguishing-agent containers.
3. Energize circuits.
4. Adjust operating controls.

3.10 TRAINING

- A. Engage a factory-authorized service representative to Owner's maintenance personnel to adjust, operate, and maintain clean-agent fire-extinguishing systems.

END OF SECTION 212200

CONTRACTOR'S APPLICATION FOR ACCEPTANCE OF GASEOUS EXTINGUISHING SYSTEM INSTALLATIONS



JOB OR CONTRACT NUMBER	DATE	FM GLOBAL OPERATIONS CENTER
INDEX NUMBER	ACCOUNT NUMBER:	<input type="checkbox"/> New System <input type="checkbox"/> Existing System
LOCATION:		
HAZARD:		

Instructions:

- The contractor will fill out "Part A" and send, along with 1 print of all drawings (including a wiring diagram when applicable), to the FM Global Operations Center serving the facility in which the system is to be installed. A separate application should be submitted for each system to be installed.
- The FM Global office will retain information and 1 print of each drawing and return a copy with "acceptance" of "Part A" indicated.
- The contractor will fill out "Part B" when the turn-over tests have been completed and will return this copy to the FM Global office.
- The next FM Global field engineer visiting the plant will complete "Part C" and will return it to the FM Global office for its files.
NOTE: If additional completed copies of this application or "accepted" prints are needed for contractor or customer requirements, they should be submitted along with these required copies and prints, and they will follow the outlined procedure. All additional copies of the application submitted will be returned by the FM Global office to the submitter after completion of "Part C".

It is understood that the signing of this form by the representative of the purchaser in no way prejudices any claim which the purchaser may have against the installer for faulty material, poor workmanship or failure to comply with the requirements of FM Global or Local Ordinances.

FINAL ACCEPTANCE OF THE INSTALLATION CANNOT BE GRANTED UNTIL THE FORM WITH "PARTS A, B, AND C PROPERLY COMPLETED HAS BEEN RECEIVED.

Parts A, B, and C appear on the following pages:

CONTRACTOR'S APPLICATION FOR ACCEPTANCE OF GASEOUS EXTINGUISHING SYSTEM INSTALLATIONS



Part A

Plans and Specifications

NAME OF CUSTOMER	STREET ADDRESS
CITY/STATE/PROVINCE/POSTAL CODE & COUNTRY	DRAWINGS SUBMITTED (NOS.)
NAME & ADDRESS OF EQUIPMENT CONTRACTOR	
NAME AND ADDRESS OF EQUIPMENT MANUFACTURER	

Type of System:

<input type="checkbox"/> Local Application	<input type="checkbox"/> CO ₂ Low Pressure	<input type="checkbox"/> Inert Gas Clean Agent	Pre-Engineered? <input type="checkbox"/> Yes <input type="checkbox"/> No
<input type="checkbox"/> Total Flooding	<input type="checkbox"/> CO ₂ High Pressure	<input type="checkbox"/> Other (Describe)	FM Approved?
<input type="checkbox"/> Combination	<input type="checkbox"/> Halocarbon Clean Agent		<input type="checkbox"/> Yes <input type="checkbox"/> No

Hazard:

Location Building Name or Number	Story	Elevation Ft. (m)	Temperature Variation at Hazard Min °F(C) Max ° F(C)
Description:			
Flammable Liquids? <input type="checkbox"/> Yes <input type="checkbox"/> No	In Open Tank? <input type="checkbox"/> Yes <input type="checkbox"/> No	If "Yes", Freeboard In.	

Interlocked Associated Equipment:

Pumps <input type="checkbox"/> Yes <input type="checkbox"/> No	Fans <input type="checkbox"/> Yes <input type="checkbox"/> No	Drive Motors <input type="checkbox"/> Yes <input type="checkbox"/> No	Dampers <input type="checkbox"/> Yes <input type="checkbox"/> No	Door - Closer <input type="checkbox"/> Yes <input type="checkbox"/> No	Other (Air Conditioning) <input type="checkbox"/> Yes <input type="checkbox"/> No
If "Yes", Enumerate and Describe:					
Are they interlocked with the system? <input type="checkbox"/> Yes <input type="checkbox"/> No		If not interlocked, explain:			

Component	Manufacturer	Model	FM Approved	Miscellaneous
Cylinders			<input type="checkbox"/> Yes <input type="checkbox"/> No	Press psi (bar) Charge lbs (kg) Cap.
Detectors			<input type="checkbox"/> Yes <input type="checkbox"/> No	Cross-Zoned ? <input type="checkbox"/> Yes <input type="checkbox"/> No Supervised? <input type="checkbox"/> Yes <input type="checkbox"/> No
Actuators			<input type="checkbox"/> Yes <input type="checkbox"/> No	Supervised? <input type="checkbox"/> Yes <input type="checkbox"/> No Spares? <input type="checkbox"/> Yes <input type="checkbox"/> No
Nozzles			<input type="checkbox"/> Yes <input type="checkbox"/> No	Unobstructed Discharge? <input type="checkbox"/> Yes <input type="checkbox"/> No
Control Panel			<input type="checkbox"/> Yes <input type="checkbox"/> No	Alarms: <input type="checkbox"/> 1 st Detector <input type="checkbox"/> 2 nd Detector
Abort Switch? <input type="checkbox"/> Yes <input type="checkbox"/> No		Alarm? <input type="checkbox"/> Yes <input type="checkbox"/> No		Fault? <input type="checkbox"/> Yes <input type="checkbox"/> No
System Isolated? <input type="checkbox"/> Yes <input type="checkbox"/> No		System Operational? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Time Delay Setting: Sec.		Man. Release Mechanical? <input type="checkbox"/> Yes <input type="checkbox"/> No		Control Panel? <input type="checkbox"/> Yes <input type="checkbox"/> No
Reserve Supply? <input type="checkbox"/> Yes <input type="checkbox"/> No		Air Conditioning Shutdown? <input type="checkbox"/> Yes <input type="checkbox"/> No		Changeover: <input type="checkbox"/> Auto <input type="checkbox"/> Manual <input type="checkbox"/> DNA
Connected? <input type="checkbox"/> Yes <input type="checkbox"/> No		Fan Test Required? <input type="checkbox"/> Yes <input type="checkbox"/> No		Auto Charging? <input type="checkbox"/> Yes <input type="checkbox"/> No
Interlocks: Auto Dampers? <input type="checkbox"/> Yes <input type="checkbox"/> No		Discharge Test Required? <input type="checkbox"/> Yes <input type="checkbox"/> No		Electrical Shutdown? <input type="checkbox"/> Yes <input type="checkbox"/> No
Uncloseable Opening? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> DNA		If Yes, Area: sq. ft. (sqm)		
Panel Location (Describe):				
Cylinder Location (Describe):				
Cylinders Labeled? <input type="checkbox"/> Yes <input type="checkbox"/> No		Manual Actuator at Cylinder? <input type="checkbox"/> Yes <input type="checkbox"/> No		Design Concentration %
Plans Submitted? <input type="checkbox"/> Yes <input type="checkbox"/> No		Concentration Calculations Submitted? <input type="checkbox"/> Yes <input type="checkbox"/> No		Plans/Calculations checked/accepted By:
		Venting Calculations Submitted? <input type="checkbox"/> Yes <input type="checkbox"/> No		Plans/Calculations checked/accepted By:
Type and Model of Concentration/Fan Test Meter to be used:				
Alarm to Manned Location? <input type="checkbox"/> Yes <input type="checkbox"/> No				

Part "A" Accepted:

Subject to any changes recommended
below or noted on drawings by :

FM Global Office

Date: _____

Recommended Changes & Remarks to Above:
--

CONTRACTOR'S APPLICATION FOR ACCEPTANCE OF GASEOUS EXTINGUISHING SYSTEM INSTALLATIONS



PART "B" – INSTALLER'S TURN-OVER TEST

Concentration Test Required for "Part B" Yes No

Instructions: The turn-over tests should be made by the contractor and witnessed by a representative of the purchaser. "Part B" must be signed by the representative of both the installer and the purchaser on all copies. Insofar as possible, all defects discovered during these tests should be corrected immediately. Sufficient gas should be discharged to operate all pressure releases and interlocks. Unless a concentration test is specified in "Part A", a complete discharge of gas supply is not required. All cylinders not required for testing should be disconnected from the manifold or otherwise arranged so that their contents will not be discharged.

DETECTION DEVICES: Test at least one farthest from the release.

How Tested:	
Discharge? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Tested	Functional Test? <input type="checkbox"/> Yes <input type="checkbox"/> No
Fan Test? <input type="checkbox"/> Yes <input type="checkbox"/> No	
Number Tested:	Operating Time Satisfactory? <input type="checkbox"/> Yes <input type="checkbox"/> No
Selector Valves Operated from Detection Devices? <input type="checkbox"/> Yes <input type="checkbox"/> No	Pilot Cylinders or Master Valves Operated from Detection Devices? <input type="checkbox"/> Yes <input type="checkbox"/> No
Manual Release Operated Satisfactorily? <input type="checkbox"/> Yes <input type="checkbox"/> No	Alarms Operated Satisfactorily? <input type="checkbox"/> Yes <input type="checkbox"/> No
Pressure Operated Trips and Switches Operated Satisfactorily? <input type="checkbox"/> Yes <input type="checkbox"/> No	Interlocked Equipment Functioned Satisfactorily? <input type="checkbox"/> Yes <input type="checkbox"/> No
Electrical & Mechanical Connections Installed? <input type="checkbox"/> Yes <input type="checkbox"/> No	Electrical and Mechanical Controls Operated Satisfactorily? <input type="checkbox"/> Yes <input type="checkbox"/> No
Time* to Achieve Equilibrium Flow of Agent Sec. *Low Pressure CO ₂ Only	Timer* Set to Discharge Required Amount of Agent <input type="checkbox"/> Yes <input type="checkbox"/> No *Low Pressure CO ₂ Only
Time delay Device Operated Satisfactorily Where Provided <input type="checkbox"/> Yes <input type="checkbox"/> No Delay of Discharge Sec.	Rotating Electrical Equipment Free Deceleration Time: Minutes

Time	Concentration Low %	High %	Comments
30 Seconds	%	%	
1 Minute	%	%	
2 Minutes	%	%	
5 Minutes	%	%	
7 Minutes	%	%	
10 Minutes	%	%	
Design Concentration	%	85% Design Clean Agent Concentration	%

- Minimum (1) probe located at highest level of combustibles being protected.

Other Deficiencies or Remarks:

Part "B" Completed

This system, except as noted, is now in good operating condition And charged with required supply	Date:
Contractor:	Test Witnessed By: (For Purchaser)

CONTRACTOR'S APPLICATION FOR ACCEPTANCE OF GASEOUS EXTINGUISHING SYSTEM INSTALLATIONS



Part "C" – FM GLOBAL FIELD EXAMINATION OF COMPLETED INSTALLATION

Pneumatic Piping Test Satisfactory? <input type="checkbox"/> Yes <input type="checkbox"/> No	If NO, Were Test Results Submitted? <input type="checkbox"/> Yes <input type="checkbox"/> No	Test Pressure? <input type="checkbox"/> psi <input type="checkbox"/> kPa
Fan/Discharge Test Satisfactory? <input type="checkbox"/> Yes <input type="checkbox"/> No	If NO, Were Test Results Submitted? <input type="checkbox"/> Yes <input type="checkbox"/> No	System Acceptable? <input type="checkbox"/> Yes <input type="checkbox"/> No
"Puff Test"? <input type="checkbox"/> Yes <input type="checkbox"/> No	If NO, See Discharge Test Results	If YES, Results Acceptable? <input type="checkbox"/> Yes <input type="checkbox"/> No
Discharge Test Witnessed By FM Global Representative? <input type="checkbox"/> Yes <input type="checkbox"/> No	Results Acceptable? <input type="checkbox"/> Yes <input type="checkbox"/> No	Subject to Comments? <input type="checkbox"/> Yes <input type="checkbox"/> No
Final Acceptance by FM Global Field Engineer? <input type="checkbox"/> Yes <input type="checkbox"/> No	Accepted? <input type="checkbox"/> Yes <input type="checkbox"/> No	

Variations from Drawings or Information in Parts "A" or "B" in Completed Installation:

Other Deficiencies or Remarks:

Any Deficiencies Noted Above Have Been Corrected, and the Installation is Acceptable.

Field Engineer's Signature:	Date:
-----------------------------	-------

NOTE: If the installation is deficient in any way, list variations and deficiencies above and return to the FM Global office unsigned. Include a statement in your report, giving the name of the manufacturer of the equipment, the name of the installer, identifying the hazard and its location, commenting upon the acceptability of the installation, along with suitable recommendations for making the system "acceptable", if necessary.

If deficiencies are listed above, they will be checked by succeeding field consultant, and when all have been corrected or completed, the field consultant will sign all copies that have "Part B" completed and return them to the FM Global office. Include a statement in your report indicating the deficiencies that have been corrected, and that the installation is now acceptable.

**THE LIABILITY OF FM GLOBAL IS LIMITED TO THAT COVERED BY ITS INSURANCE POLICIES.
NO OTHER LIABILITY IS ASSUMED BY REASON OF THE APPLICATION FOR ACCEPTANCE.**

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rubber union connector packless expansion joints.
2. Flexible-hose packless expansion joints.
3. Metal-bellows packless expansion joints.
4. Externally pressurized metal-bellows packless expansion joints.
5. Rubber packless expansion joints.
6. Grooved-joint expansion joints.
7. Alignment guides and anchors.
8. Pipe loops and swing connections.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
- C. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKLESS EXPANSION JOINTS

- A. Rubber Union Connector Expansion Joints RUEJ-01:
 - 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. Unaflex
 - b. Proco Products
 - c. Mason Industries Inc.
 - 2. Material: Twin reinforced-rubber spheres with external restraining cables.
 - 3. Minimum Pressure Rating: 150 psig at 170 deg F, unless otherwise indicated.
 - 4. End Connections for NPS 2 and Smaller: Threaded.
- B. Flexible-Hose Packless Expansion Joints FHEJ-01:
 - 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. Flex Pression Ltd
 - b. Flex-Hose Co.
 - c. Mason Industries Inc.
 - 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.

3. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 4. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
 5. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
 6. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged welded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
- C. Metal-Bellows Packless Expansion Joints MBEJ-01:
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. Unaflex
 - b. Proco Products
 - c. Mason Industries Inc.
 2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
 3. Type: Circular, corrugated bellows with external tie rods.
 4. Minimum Pressure Rating: 150 psig 175 psig 200 psig, unless otherwise indicated.
 5. Configuration: Single joint Single joint with base and double joint with base class(es), unless otherwise indicated.
 6. Expansion Joints for Copper Tubing: Single- or multi- ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint or threaded.
 7. Expansion Joints for Steel Piping: Single- or multi- ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.

- a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
- D. Externally Pressurized Metal-Bellows Packless Expansion Joints EPEJ-01:
- 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. U.S. Bellows, Inc.
 - b. Flex-Hose Co., Inc.
 - c. Mason Industries Inc.
 - 2. Minimum Pressure Rating: 150 psig 200 psig 300 psig, unless otherwise indicated.
 - 3. Description:
 - a. Totally enclosed, externally pressurized, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
 - b. Carbon-steel housing.
 - c. Drain plugs and lifting lug for NPS 3 and larger.
 - d. Bellows shall have operating clearance between the internal pipe sleeves and the external shrouds.
 - e. Joints shall be supplied with a built-in scale to confirm the starting position and operating movement.
 - f. Joint Axial Movement: 4 inches 6 inches 8 inches of compression and 0.75 inch 1 inch 2 inches of extension.
 - 4. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
 - 5. End Connection Configuration: Flanged; one raised, fixed and one floating flange.
- E. Rubber Packless Expansion Joints REJ-01:
- 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. Unaflex
 - b. Proco Products
 - c. Mason Industries Inc.
 - 2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
 - 3. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
 - 4. Arch Type: Single or multiple arches with external control rods.
 - 5. Spherical Type: Single or multiple spheres with external control rods.
 - 6. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F

7. Material for Water: Butyl rubber Buna-N Chlorosulfonated polyethylene synthetic rubber Chlorosulfonyl-polyethylene rubber Ethylene-propylene-diene terpolymer rubber Natural rubber.
8. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.3 GROOVED-JOINT EXPANSION JOINTS

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. Anvil International
 - b. Shurjoint Piping Products
 - c. Victaulic Company
- B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
- C. Standard: AWWA C606, for grooved joints.
- D. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.
- E. Couplings: Five, Seven, 10, 12, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water ethylene-propylene-diene terpolymer rubber gasket suitable for cold and hot water, and bolts and nuts.

2.4 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides AG-01:
 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. U.S. Bellows, Inc.
 - b. Flex-Hose Co., Inc.
 - c. Mason Industries Inc.
 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.
- B. Anchor Materials:
 1. Steel Shapes and Plates: ASTM A 36/A 36M.
 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
 3. Washers: ASTM F 844, steel, plain, flat washers.

4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- C. Install rubber packless expansion joints according to FSA-PSJ-703.
- D. Install grooved-joint expansion joints to grooved-end steel piping.

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 220516

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

- 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:
- B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.

2.2 SLEEVE-SEAL SYSTEMS

- 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. Jay R. Smith Mfg. Co
2. Zurn Industries, LLC

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber High-temperature-silicone Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Carbon steel Composite plastic Stainless steel Stainless steel, Type 316.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633 Stainless steel Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

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. Calpico, Inc.
2. GPT; an Enpro Industries
3. Proco Products, Inc.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 - 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. Dow Corning Corporation
 - b. Polymeric Systems, Inc.
 - c. GE Construction Sealants
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
 - 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. May National Associates,
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
 - 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. Smooth-On

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.

- C. Install sleeves in concrete slabs as new slabs are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Use grout or silicone sealant to seal the space around outside of sleeve-seal fittings.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system
Steel pipe sleeves with sleeve-seal system Sleeve-seal fittings.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 2. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

3.6 GROUT:

- A. Refer to Section 033000, "Cast in Place Concrete" for non-shrink grout.

END OF SECTION 220517

SECTION 220518 - ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Escutcheons.

1.2 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS:

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 1. Escutcheons for Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
- b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- c. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
- d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.

3.2 FIELD QUALITY CONTROL:

- A. Replace broken and damaged escutcheons using new materials.

END OF SECTION 220518

SECTION 220523 – GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Steel ball valves.
4. Iron ball valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Iron swing check valves with closure control.
8. Iron, grooved-end swing check valves.
9. Iron, center guided check valves.
10. Iron, plate-type check valves
11. Bronze gate valves.
12. Iron gate valves.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. RS: Rising stem.
- E. OS&Y: Outside screw and yoke.

1.3 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of valve.
 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.4 INFORMATIONAL SUBMITALLS:

A. Quality Assurance Submittals:

1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, weld ends, and soldered ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Set check valves in either closed or open position.
5. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.9 for building services piping valves.

- C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- D. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Bypass and Drain Connections: MSS SP-45.
- I. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

- A. Brass Ball Valves, One-Piece:
 - 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. Apollo Valves; Conbraco Industries
 - b. KITZ Corporation
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 400 psig.
 - c. Body Design: One piece.
 - d. Body Material: Forged brass or bronze.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass or stainless steel.
 - h. Ball: Chrome-plated brass or stainless steel.
 - i. Port: Reduced.
- B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim:

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. Apollo Valves; Conbraco Industries
 - b. KITZ Corporation
 - c. NIBCO Inc.

2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.

C. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

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. Apollo Valves; Conbraco Industries
 - b. KITZ Corporation
 - c. Jomar Valve

2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Forged brass.
 - e. Ends: Threaded and soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Full.

D. Brass Ball Valves, Two-Piece with Regular Port and Brass Trim:

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. Apollo Valves; Conbraco Industries

- b. WATTS
- c. NIBCO Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig.
- c. Body Design: Two piece.
- d. Body Material: Forged brass.
- e. Ends: Threaded and soldered.
- f. Seats: PTFE.
- g. Stem: Brass.
- h. Ball: Chrome-plated brass.
- i. Port: Regular.

2.3 BRONZE BALL VALVES

A. Bronze Ball Valves, One-Piece with Bronze Trim:

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. Apollo Valves; Conbraco Industries
- b. WATTS
- c. NIBCO Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 400 psig.
- c. Body Design: One piece.
- d. Body Material: Bronze.
- e. Ends: Threaded.
- f. Seats: PTFE.
- g. Stem: Bronze.
- h. Ball: Chrome-plated brass.
- i. Port: Reduced.

B. Bronze Ball Valves, One-Piece with Stainless-Steel Trim:

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. Apollo Valves; Conbraco Industries
- b. WATTS
- c. NIBCO Inc.

2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: One piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Reduced.

C. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim:

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. Apollo Valves; Conbraco Industries
 - b. WATTS
 - c. NIBCO Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig.
- c. Body Design: Two piece.
- d. Body Material: Bronze.
- e. Ends: Threaded and soldered.
- f. Seats: PTFE.
- g. Stem: Bronze or brass.
- h. Ball: Chrome-plated brass.
- i. Port: Full.

D. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

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. Apollo Valves; Conbraco Industries
 - b. WATTS
 - c. NIBCO Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig.

- c. Body Design: Two piece.
- d. Body Material: Bronze.
- e. Ends: Threaded or soldered.
- f. Seats: PTFE.
- g. Stem: Stainless steel.
- h. Ball: Stainless steel, vented.
- i. Port: Full.

E. Bronze Ball Valves, Two-Piece with Regular Port and Bronze or Brass Trim:

- 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. Apollo Valves; Conbraco Industries
- b. WATTS
- c. NIBCO Inc.

- 2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig.
- c. Body Design: Two piece.
- d. Body Material: Bronze.
- e. Ends: Threaded.
- f. Seats: PTFE.
- g. Stem: Bronze or brass.
- h. Ball: Chrome-plated brass.
- i. Port: Regular.

F. Bronze Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:

- 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. Apollo Valves; Conbraco Industries
- b. WATTS
- c. NIBCO Inc.

- 2. Description:

- a. Standard: MSS SP-110.
- b. CWP Rating: 600 psig.
- c. Body Design: Two piece.
- d. Body Material: Bronze.
- e. Ends: Threaded.
- f. Seats: PTFE.
- g. Stem: Stainless steel.

- h. Ball: Stainless steel, vented.
- i. Port: Regular.

G. Bronze Ball Valves, Three-Piece with Full Port and Bronze or Brass Trim:

- 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. Apollo Valves; Conbraco Industries
 - b. WATTS
 - c. NIBCO Inc.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Bronze or brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.

H. Bronze Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:

- 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. Apollo Valves; Conbraco Industries
 - b. WATTS
 - c. NIBCO Inc.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Full.

I. Bronze Ball Valves, Three-Piece with Regular Port and Bronze Trim:

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. Apollo Valves; Conbraco Industries
 - b. Jamesbusry;Metso
 - c. NIBCO Inc.

2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece
 - d. Body Material: Bronze
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE.
 - g. Stem: Bronze.
 - h. Ball: Chrome-plated brass.
 - i. Port: Regular.

J. Bronze Ball Valves, Three-Piece with Regular Port and Stainless-Steel Trim:

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. Apollo Valves; Conbraco Industries
 - b. Jamesbusry;Metso
 - c. NIBCO Inc.

2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Three piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Regular.

2.4 STEEL BALL VALVES

A. Steel Ball Valves with Full Port, Class 150:

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. Apollo Valves; Conbraco Industries
 - b. Jamesbusry;Metso
 - c. NIBCO Inc.

2. Description:
 - a. Standard: MSS SP-72.
 - b. CWP Rating: 285 psig.
 - c. Body Design: Split body.
 - d. Body Material: Carbon steel, ASTM A 216, Type WCB.
 - e. Ends: Flanged or threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Full.

B. Steel Ball Valves with Regular Port, Class 150:

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. Apollo Valves; Conbraco Industries
 - b. Jamesbusry; Metso
 - c. NIBCO Inc.

2. Description:
 - a. Standard: MSS SP-72.
 - b. CWP Rating: 285 psig.
 - c. Body Design: Uni-body.
 - d. Body Material: Carbon steel, ASTM A 216, Type WCB.
 - e. Ends: Flanged or threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel, vented.
 - i. Port: Regular.

2.5 IRON BALL VALVES

A. Iron Ball Valves, Class 125:

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. Apollo Valves; Conbraco Industries
 - b. KITZ corporation
 - c. WATTS

2. Description:
 - a. Standard: MSS SP-72.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Split body.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Ends: Flanged or threaded.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel.
 - i. Port: Full.

2.6 BRONZE LIFT CHECK VALVES

- A. Bronze Lift Check Valves with Bronze Disc, Class 125:
 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. Crane; Crane Energy Flow Solutions
 - b. Jenkins Valves; Crane Energy Flow Solutions
 - c. Stockham; Crane Energy Flow Solutions

 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.

- B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125, :
 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. NIBCO Inc.

- b. WATTS
- c. Flo Fab Inc.

2. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 200 psig.
- c. Body Design: Vertical flow.
- d. Body Material: ASTM B 61 or ASTM B 62, bronze.
- e. Ends: Threaded or soldered. See valve schedule articles.
- f. Disc: NBR, PTFE.

2.7 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

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 followings:

- a. NIBCO Inc.
- b. WATTS
- c. KITZ Corporation

2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded or soldered. See valve schedule articles.
- f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:

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 followings:

- a. NIBCO Inc.
- b. WATTS
- c. KITZ Corporation

2. Description:

- a. Standard: MSS SP-80, Type 4.
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.

- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded or soldered. See valve schedule articles.
- f. Disc: PTFE.

2.8 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:

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. NIBCO Inc.
- b. WATTS
- c. KITZ Corporation

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged or threaded. See valve schedule articles.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.

B. Iron Swing Check Valves with Nonmetallic-to-Metal Seats, Class 125:

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 followings:

- a. Crane; Crane Energy Flow Solutions
- b. Stockham; Crane Energy Flow Solutions

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged or threaded. See valve schedule articles.
- f. Trim: Composition.
- g. Seat Ring: Bronze.
- h. Disc Holder: Bronze.
- i. Disc: PTFE.
- j. Gasket: Asbestos free.

2.9 BRONZE GATE VALVES

A. Bronze Gate Valves, NRS, Class 125:

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. WATTS
 - b. KITZ Corporation
 - c. NIBCO Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Material: Bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

B. Bronze Gate Valves, RS, Class 125:

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. NIBCO, Inc,
 - b. WATTS
 - c. KITZ Corporation
2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 200 psig.
 - c. Body Material: Bronze with integral seat and screw-in bonnet.
 - d. Ends: Threaded or solder joint.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron, bronze, or aluminum.

2.10 IRON GATE VALVES

A. Iron Gate Valves, OS&Y, Class 125:

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. Apollo Valves; Conbraco Industries
 - b. KITZ corporation
 - c. WATTS
 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Material: Gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.
- B. Iron Gate Valves, NRS, Class 150:
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. NIBCO, Inc,
 - b. WATTS
 - c. KITZ Corporation
 2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Material: Gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.
 - g. Packing and Gasket: Asbestos free.
- C. Iron Gate Valves, OS&Y, Class 125:
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. NIBCO, Inc,
 - b. WATTS
 - c. KITZ Corporation
 2. Description:
 - a. Standard: MSS SP-70, Type I.

- b. CWP Rating: 200 psig.
- c. Body Material: Gray iron with bolted bonnet.
- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Disc: Solid wedge.
- g. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
- F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Use gate valves for shutoff service only.
- C. For Grooved-End Copper Tubing and Steel Piping: Gate valve ends may be grooved.
- D. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Brass ball valve, one piece.
 - 3. Bronze ball valve, one piece with bronze stainless-steel trim.
 - 4. Brass ball valves, two-piece with full regular port and brass stainless-steel trim.
 - 5. Bronze ball valves, two-piece with full regular port and bronze or brass stainless-steel trim.
 - 6. Brass ball valves, three-piece with full port and brass stainless-steel trim.
 - 7. Bronze ball valves, three-piece with full port and bronze or brass stainless-steel trim.
 - 8. Bronze ball valves, two-piece with regular port and bronze stainless-steel trim.
 - 9. Bronze swing check valves with bronze nonmetallic disc, Class 125 with soldered or threaded end connections.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Steel and Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
 - 2. Steel ball valves, Class 150 with full port.
 - 3. Iron ball valves, Class 150.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe positioning systems.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment"

1.2 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.4 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
- D. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel stainless steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

- 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. Buckarooz Inc.
 2. Pipe Shields Inc.
 3. Piping Technology & , Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 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.

2.5 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

- D. 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.
- E. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. 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.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. 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.
- L. Insulated Piping:
1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

- a. Option: Thermal-hanger shield inserts may be used.
- 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used.
- 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
- 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.3 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.

3.4 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099123 "Interior Painting."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 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 metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use padded hangers for piping that is subject to scratching.
- H. Use thermal-hanger shield inserts for insulated piping and tubing.
- I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
13. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
14. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
15. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
16. 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.
17. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
18. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
19. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
20. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 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.

- K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe-riser resilient supports.
2. Resilient pipe guides.
3. Elastomeric hangers.
4. Spring hangers.
5. Snubbers.
6. Restraint channel bracings.
7. Restraint cables.
8. Seismic-restraint accessories.
9. Mechanical anchor bolts.
10. Adhesive anchor bolts.

B. Related Requirements:

1. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

1.2 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.3 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Shop Drawings:
 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

D. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.
3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
4. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
5. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths,

and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

- c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer and testing agency.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV.

- a. Seismic Design Category. C.
- 3. Design Spectral Response Acceleration at Short Periods (0.2 Second)(S_{DS}): 0.182.
- 4. Design Spectral Response Acceleration at 1.0-Second Period S_{DI} : 0.064.

2.2 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.
 - 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 - 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.3 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.
 - 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.4 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 - 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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation
 - c. Novia; A Division of C&P
 - 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 - 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.5 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation
 - c. Novia; A Division of C&P
 2. 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.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.6 SNUBBERS

- 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:
- a. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation
 - c. Novia; A Division of C&P
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

2.7 RESTRAINT CHANNEL BRACINGS

- 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. Hiti, Inc.
 - 2. Mason Industries, Inc.
 - 3. Unitrust; Port of Atkore International
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.8 RESTRAINT CABLES

- 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. Gripple Inc.
 - 2. Mason Industries, Inc.
 - 3. Novia; A Division of C&P
- B. Restraint Cables: ASTM A 603 galvanized ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.9 SEISMIC-RESTRAINT ACCESSORIES

- 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. Hilti, Inc.
 - 2. Kinetics Noise Control
 - 3. Mason Industries, Inc.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections Reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.10 MECHANICAL ANCHOR BOLTS

- 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. Hilti, Inc.
 - 2. Kinetics Noise Control
 - 3. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.11 ADHESIVE ANCHOR BOLTS

- 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. Hilti, Inc.
 - 2. Kinetics Noise Control
 - 3. Mason Industries, Inc.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Equipment Restraints:
 - 1. Install seismic snubbers on fire protection equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- D. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.

- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. 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.
- I. 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.
- J. Drilled-in Anchors:
 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. 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 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 221116 "Domestic Water Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Schedule test with Owner, through Engineer, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - 3. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - 4. Test at least four of each type and size of installed anchors and fasteners selected by the Engineer.
 - 5. Test to 90 percent of rated proof load of device.
 - 6. Measure isolator restraint clearance.
 - 7. Measure isolator deflection.
 - 8. Verify snubber minimum clearances.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 220548

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.
5. Warning tags.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- E. Valve numbering scheme.
- F. Valve Schedules: For each piping system to include in maintenance manuals as specified in Form 817 Article 1.20-1.08.14 subsection 2 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

PART 2 - PRODUCTS

2.1 WARNING SIGNS AND LABELS

- 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. Emedco
 2. Kolbi Pipe Marker Co
 3. LEM Products Inc.

- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Black, Blue, Red, White, Yellow.
- D. Background Color: Black, Blue, Red, White, Yellow.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.2 PIPE LABELS

- 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. Emedco
 2. Kolbi Pipe Marker Co
 3. LEM Products Inc.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.3 VALVE TAGS

- 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. Kolbi Pipe Marker Co.
 2. Brimar Industries, Inc.
 3. LEM Products Inc.
- B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain or beaded chain or S-hook.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.

2.4 WARNING TAGS

- 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. Kolbi Pipe Marker Co.
 2. Brimar Industries, Inc.
 3. LEM Products Inc.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 1. Size: 3 by 5-1/4 inches minimum Approximately 4 by 7 inches.
 2. Fasteners: Brass grommet and wire Reinforced grommet and wire or string.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, 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.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
1. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 2. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Safety black Safety purple Safety white Safety gray.
 - b. Letter Color: Black White.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches 2 inches, round square.
 - b. Hot Water: 1-1/2 inches 2 inches, round square.
 2. Valve-Tag Colors:
 - a. Cold Water: Natural Safety green.
 - b. Hot Water: Natural Safety green.
 3. Letter Colors:
 - a. Cold Water: White.
 - b. Hot Water: White.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY:

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Domestic recirculating hot-water piping.
 - 4. Supplies and drains for handicap-accessible lavatories and sinks.
- B. Related Sections:
 - 1. Section 230719 "HVAC Piping Insulation."

1.2 DEFINITIONS:

- A. ASJ: All Service Jacket.
- B. SSL: Self Sealing Lap.

1.3 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

- D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
 - 1. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS:

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.
- D. Quality Assurance Submittals:
 - 1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 QUALITY ASSURANCE:

- A. Source Limitations: Obtain plumbing and HVAC insulation from a single manufacturer in accordance with Form 817.
- B. 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.
- C. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- D. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

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 Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

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 Piping Schedules 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. 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. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000-Degree Pipe Insulation.
 - c. Manson Insulation Inc.; Alley-K.
 - d. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in Part 2.5 "Factory-Applied Jackets".

2.2 ADHESIVES:

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
 - d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. PVC Jacket Adhesive: Compatible with PVC jacket.

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. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, 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.

2.4 SEALANTS:

A. Joint Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.

4. Color: White or gray.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ and PVC Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 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-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.6 FIELD-APPLIED JACKETS:

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.

4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Underground Direct-Buried Jacket: 125-mil thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Venture Tape Corp
 - b. Polyguard Products Inc.

2.7 TAPES:

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, 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. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

2.8 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 and Seals.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

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. C & F Wire.

2.9 PROTECTIVE SHIELDING GUARDS:

A. Protective Shielding Pipe Covers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Model No. 103 as manufactured by Truebro, Inc., or an approved equal.
2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements. Include manufacturer's standard fasteners, straps, and adhesives. Cover for stops and handles shall be removable. Color shall be white.

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.
- B. 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.

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 4 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. Cleanouts.

3.4 PENETRATIONS:

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 078413, "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- C. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413, "Penetration Firestopping."
- D. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

3.5 GENERAL PIPE INSULATION INSTALLATION:

- A. Requirements herein generally apply to all insulation materials except where more specific requirements are specified elsewhere in this Section.
- B. Insulation Installation on Fittings, Valves, Strainers, and Unions:
 - 1. Install insulation over fittings, valves, strainers, 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.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts.
 - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and

- jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. 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 and finish with finishing cement, mastic, and flashing sealant.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION:

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3.7 FIELD-APPLIED JACKET INSTALLATION:

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.8 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. Underground piping.
2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.9 INDOOR PIPING INSULATION SCHEDULE:

A. Domestic Cold Water:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

B. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

C. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - D. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities: Refer to Part 2 of this Specification.
 - E. 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.
- 3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE:
- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
 - B. Piping, Exposed: Wash Bay.
 - 1. PVC: 20 mils thick.
- 3.11 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET
- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220719

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. Piping joining materials.
4. Encasement for piping.
5. Transition fittings.
6. Dielectric fittings.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For transition fittings and dielectric fittings.

1.3 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

1.4 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Coordinate service interruption with the Engineer in accordance with other Contract requirements.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61. Plastic piping components shall be marked with "NSF-pw."

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.
- G. Appurtenances for Grooved-End Copper Tubing:
 - 1. Manufacturers: Subject to compliance with requirements, provide products but are not limited to, the following:
 - a. Shurjoint Piping Products
 - b. Smith-Cooper International
 - c. Star Pipe Products
 - d. Victaulic Company.
 - 2. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75 copper tube or ASTM B 584 bronze castings.
 - 3. Mechanical Couplings for Grooved-End Copper Tubing:
 - a. Copper-tube dimensions and design similar to AWWA C606.
 - b. Ferrous housing sections.
 - c. EPDM-rubber gaskets suitable for hot and cold water.
 - d. Bolts and nuts.
 - e. Minimum Pressure Rating: 300 psig.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: Sheet or tube.
- C. Color: Black or natural

2.5 TRANSITION FITTINGS

- A. General Requirements:
1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
1. Manufacturers: Subject to compliance with requirements, provide products but are not limited to, the following:
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Piping Specialties Products.
 - c. Ford Meter Box Company, Inc. (The).
 - d. Viking Johnson.

2.6 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products but are not limited to, the following:
 - a. Hart Industries International, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.
 - c. Wilkins; a Zurn company.
 - 2. Standard: ASSE 1079.
 - 3. Pressure Rating: 125 psig minimum at 180 deg F
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, provide products but are not limited to, the following:
 - a. Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - b. Central Plastics Company.
 - c. Watts; a division of Watts Water Technologies, Inc.
 - d. Wilkins; a Zurn company.
 - 2. Standard: ASSE 1079.
 - 3. Factory-fabricated, bolted, companion-flange assembly.
 - 4. Pressure Rating: 125 psig minimum at 180 deg F.
 - 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
 - 1. Manufacturers: Subject to compliance with requirements, provide products but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Nonconducting materials for field assembly of companion flanges.
 - 3. Pressure Rating: 150 psig.

4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products but are not limited to, the following:
 - a. Grinnell Mechanical Products; Tyco Fire Products LP.
 - b. Precision Plumbing Products, Inc.
 - c. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Plans indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- E. Install piping to permit valve servicing.
- F. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- G. Install piping free of sags and bends.

- H. Install fittings for changes in direction and branch connections.
- I. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- J. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."
- K. Install ball valves on all branch supply lines

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.3 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings couplings or nipples nipples unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges flange kits nipples.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
- J. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Plans indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 2. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
- b. During installation, notify authorities having jurisdiction at least 3 calendar days before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. 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 it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Open throttling valves to proper setting.
 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to authorities having jurisdiction.

- B. Clean non-potable domestic water piping as follows:
 - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 - 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be:
 - 1. Hard copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- E. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
 - 1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 - 2. Hard copper tube, ASTM B 88, Type L ASTM B 88, Type M; cast- or wrought-copper, solder-joint fittings; and brazed soldered joints.
 - 3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
 - 4. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper push-on-joint fittings; and push-on joints.

- F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 , shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L ASTM B 88, Type M; cast- or wrought-copper, solder-joint fittings; and brazed soldered joints.
 2. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; copper pressure-seal-joint fittings; and pressure-sealed joints.
 3. Hard copper tube, ASTM B 88, Type L or ASTM B 88, Type M; grooved-joint, copper-tube appurtenances; and grooved joints.

3.12 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 2. Throttling Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated Memory-stop balancing valves.
 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221119 – DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Backflow preventers.
 - 2. Balancing valves.
 - 3. Temperature-actuated, water mixing valves.
 - 4. Water-hammer arresters.
 - 5. Trap-seal primer valves.

1.2 QUALITY ASSURANCE

- A. The work of this section shall be performed by a company which specializes in the type of domestic water piping specialties work required for this Project, with a minimum of 5 years of documented successful experience and shall be performed by skilled workmen thoroughly experienced in the necessary crafts.
- B. Manufacturer shall specialize in manufacturing the type of domestic water piping specialties specified in this section, with a minimum of 5 years of documented successful experience, and have the facilities capable of meeting all requirements of Contract Documents as a single-source responsibility and warranty.
- C. Manufacturer's identification tags or marks are not acceptable on surfaces which will remain exposed to view after installation.
 - 1. Evidence of "patching" after removal of tags or marks is not acceptable.

1.3 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
- C. Shop Drawings: For domestic water piping specialties.
 - 1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in operation and maintenance manuals as specified in Form 817 Article 1.20-1.08.14 subsection 2 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 BACKFLOW PREVENTERS

- A. Reduced-Pressure-zone assemblies:
 - 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. FEBCO; a division of Watts Water Technologies, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - 2. Standard: ASSE 1013.
 - 3. Operation: Continuous-pressure applications.
 - 4. Pressure Loss: 10 psig maximum, through middle third of flow range.
 - 5. Size: As indicated on drawings
 - 6. Body: Bronze that is FDA approved for NPS 2-1/2 and larger.
 - 7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
 - 8. Configuration: As indicated on drawings.
 - 9. Accessories:
 - a. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

- b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Backflow-Preventer Test Kits:

- 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. Conbraco Industries, Inc.
 - b. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - c. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
- 2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

- 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. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - b. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - c. NIBCO
- 2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
- 3. Body: Brass.
- 4. Size: Same as connected piping, but not larger than NPS 2.
- 5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.5 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

- 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. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - b. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - c. NIBCO
2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
 3. Pressure Rating: 125 psig minimum unless otherwise indicated.
 4. Body: Bronze body with corrosion-resistant interior components.
 5. Temperature Control: Adjustable.
 6. Inlets and Outlet: Threaded.
 7. Finish: Rough or chrome-plated bronze.
 8. Tempered-Water Setting: 105 deg F.
 9. Tempered-Water Design Flow Rate: Set to maximum faucet GPM.
 10. Drain: Pipe plug

2.6 Water Hammer Arresters:

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. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - b. Precision Plumbing Products
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.7 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

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. Precision Plumbing Products
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.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Install balancing valves in locations where they can easily be adjusted.
- C. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
- D. Install water-hammer arresters in water piping according to PDI-WH 201.
- E. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

3.2 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 1. Backflow preventers.
 2. Primary, thermostatic, water mixing valves.
 3. Supply-type, trap-seal primer valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 221119

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.2 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.3 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Service: Coordinate service interruption with the Engineer in accordance with other Contract requirements.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.

- B. CISPI, Hubless-Piping Couplings:

- 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. ANACO-Husky.
 - b. Matco-Norca, Inc.
 - c. Mission Rubber Company; a division of MCP Industries, Inc.

- 2. Standards: ASTM C 1277 and CISPI 310.

- 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

- C. Heavy-Duty, Hubless-Piping Couplings:

- 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. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Mission Rubber Company; a division of MCP Industries, Inc.

- 2. Standards: ASTM C 1277 and ASTM C 1540.

- 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

- D. Cast-Iron, Hubless-Piping Couplings:

- 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. MG Piping Products Company.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 GALVANIZED-STEEL PIPE AND FITTINGS

- A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. threaded ends matching joining method.
- B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.
- C. Cast-Iron Flanges: ASME B16.1, Class 125.
 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.4 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B 88, Type L and Type M (ASTM B 88M, Type B and Type C), water tube, drawn temper.
- D. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
- E. Copper Pressure Fittings:
 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.5 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:
 - 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) Dallas Specialty & Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
4. Shielded, Nonpressure Transition Couplings:
 - 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) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company; a division of MCP Industries, Inc.
 - b. Standard: ASTM C 1460.

- c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
5. Pressure Transition Couplings:
- 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) Dresser, Inc.
 - 2) EBAA Iron, Inc.
 - 3) Smith-Blair, Inc.; a Sensus company.
 - 4) The Ford Meter Box Company, Inc.
 - b. Standard: AWWA C219.
 - c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - d. Center-Sleeve Material: Manufacturer's standard.
 - e. Gasket Material: Natural or synthetic rubber.
 - f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

- 1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- 2. Dielectric Unions:
 - 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) Capitol Manufacturing Company.
 - 2) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 3) Wilkins; a Zurn company.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 125 psig minimum at 180 deg F .
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
- 3. Dielectric Flanges:

- 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) Central Plastics Company
 - 2) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - 3) Wilkins; a Zurn company.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 125 psig minimum at 180 deg .
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Insulating Kits:
- 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) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - 4) Pipeline Seal and Insulator, Inc.
 - b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig .
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.
5. Dielectric Nipples:
- 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) Grinnell Mechanical Products.
 - 2) Precision Plumbing Products, Inc.
 - 3) Victaulic Company.

b. Description:

- 1) Standard: IAPMO PS 66
- 2) Electroplated steel nipple.
- 3) Pressure Rating: 300 psig at 225 deg F.
- 4) End Connections: Male threaded or grooved.
- 5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Plans 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.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install steel piping according to applicable plumbing code.
- O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- P. Install engineered soil and waste drainage and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

- A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- B. 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.
- C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- D. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

3.3 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Unshielded nonpressure transition couplings.
- B. Dielectric Fittings:
 - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
 - 3. Dielectric Fittings for NPS 2-1/2 to NPS 4
 - 4. Use dielectric flanges.
 - 5. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 - 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Support horizontal piping and tubing within 12 inches of each fitting[, valve,] and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.

- H. Install supports for vertical steel piping every 15 feet.
- I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
- J. Install supports for vertical copper tubing every 10 feet.
- K. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Plans indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 5. Comply with requirements for, cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
 6. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. 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.

3.6 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 3 calendar days before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.

Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.8 CLEANING AND PROTECTION

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

3.9 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings[and solvent stack fitting heavy-duty hubless-piping couplings; and coupled joints.
 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 4. Copper DWV tube, copper drainage fittings, and soldered joints.
 5. Dissimilar Pipe-Material Couplings: Unshielded nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings and solvent stack fittings; heavy-duty hubless-piping couplings; and coupled joints.
 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 4. Copper DWV tube, copper drainage fittings, and soldered joints.
 - a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2 (DN 65 and DN 90): Hard copper tube, Type M (Type C); copper pressure fittings; and soldered joints.
 5. Dissimilar Pipe-Material Couplings: Unshielded nonpressure transition couplings.
- E. Aboveground, vent piping NPS 5 and larger shall be any of the following:
1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 3. Galvanized-steel pipe, drainage fittings, and threaded joints.
 4. Dissimilar Pipe-Material Couplings: Unshielded nonpressure transition couplings.

END OF SECTION 221316

SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Floor drains.

B. Related Requirements:

1. Section 221423 "Storm Drainage Piping Specialties" for storm drainage piping inside the building, drainage piping specialties, and drains.

1.2 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. HDPE: High-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PP: Polypropylene plastic.

E. PVC: Polyvinyl chloride plastic.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts :

1. ASME A112.36.2M, Cast-Iron Cleanouts:

- 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) Smith, Jay R. Mfg. Co.
- 2) Watts Drainage Products.
- 3) Zurn Plumbing Products Group.

B. Cast-Iron Wall Cleanouts:

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. Smith, Jay R. Mfg. Co.
- b. Watts Drainage Products.
- c. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
5. Closure: Countersunk, drilled-and-threaded brass or cast iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, deep, chrome-plated bronze, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

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. Smith, Jay R. Mfg. Co.
- b. Watts Drainage Products.
- c. Zurn Plumbing Products Group;

2. Standard: ASME A112.6.3.
3. Pattern: Floor Sanitary drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.

8. Outlet: Bottom.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

2.3 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft., 0.0625-inch thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft., 0.0469-inch thickness.
3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft., 0.016-inch thickness.
2. Vent Pipe Flashing: 8 oz./sq. ft., 0.0106-inch thickness.

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Assemble open drain fittings and install with top of hub 1 inch above floor.
- F. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- G. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 2. Size: Same as floor drain inlet.
- H. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- J. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- K. Install wood-blocking reinforcement for wall-mounting-type specialties.
- L. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Plans indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 2. Copper Sheets: Solder joints of copper sheets.

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

3.4 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

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

END OF SECTION 221319

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous storm drainage piping specialties.
2. Cleanouts.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping penetrations.

1.2 ACTION SUBMITTALS

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

1.3 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

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. Smith, Jay R. Mfg. Co.
 - b. Watts Drainage Products.
 - c. Zurn Plumbing Products Group
2. Standard: ASME A112.36.2M.

3. Size: Same as connected branch.
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or No-hub, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk cast-iron plug.
6. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

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. Smith, Jay R. Mfg. Co.
 - b. Watts Drainage Products.
 - c. Zurn Plumbing Products Group
2. Standard: ASME A112.36.2M
3. Size: Same as connected branch.
4. Type: Cast-iron soil pipe with cast-iron ferrule.
5. Body or Ferrule: Cast iron.
6. Clamping Device: AS Required.
7. Outlet Connection: Hub with inside caulk.
8. Closure: Cast-iron plug.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Painted cast iron.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Extra-Heavy Duty.
13. Riser: ASTM A 74, Extra-Heavy Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

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. Smith, Jay R. Mfg. Co.
 - b. Watts Drainage Products.
 - c. Zurn Plumbing Products Group
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.
5. Closure Plug:
 - a. Cast iron.
 - b. Countersunk or raised head.

- c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as, or not more than, one size smaller than cleanout size.
- 6. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
 - 7. Wall Access: Round, stainless-steel wall-installation frame and cover.
- D. Test Tees:
- 1. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301.
 - 2. Size: Same as connected drainage piping.
 - 3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
 - 4. Closure Plug: Countersunk or raised head, brass.
 - 5. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 - 4. Locate cleanouts at base of each vertical storm piping conductor.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install test tees in vertical conductors and near floor.
- E. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- F. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping."

3.2 FLASHING INSTALLATION

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors with waterproof membrane.
- C. Set flashing on floors in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.

3.3 PROTECTION

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

END OF SECTION 221423

SECTION 224213- COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Water closets.
2. Flushometer valves.
3. Toilet seats.

1.2 ACTION SUBMITTALS

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 SPARE PARTS

A. Furnish spare parts to the Engineer that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 WALL-MOUNTED WATER CLOSETS

A. Water Closets: Wall mounted, top spud

1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard water closets to match water closets in the existing building, similar to TOTO CT708EG, or an approved equal.
2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.2.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet direct-fed action
 - d. Style: Flushometer valve
 - e. Height: Standard.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Spud Size and Location: NPS 1-1/2; top
3. Support:
 - a. Standard: ASME A112.6.1M.
 - b. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.
 - c. Water-Closet Mounting Height: Standard/Handicapped/Elderly according to ICC/ANSI A117.1

2.2 FLUSHOMETER VALVES

- A. Flushometer Valves: Flushometer Valves shall be Model Flushboy “Water Saver” as manufactured by Delany. No “Or Equals” will be considered.

2.3 TOILET SEATS

- A. Toilet Seats: Toilet Seats shall be Model 5901.100 (color white) as manufactured by American Standard, or an approved equal.
- B. Construction: Solid plastic construction, elongated, open front, without cover and stainless steel check hinge.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Water-Closet Installation:

- 1. Install level and plumb according to roughing-in drawings.
- 2. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

- 1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
- 2. Use carrier supports with waste-fitting assembly and seal.
- 3. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

- 1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
- 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
- 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

- 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
- 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
- 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213

SECTION 224216 - COMMERCIAL LAVATORIES AND SINKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lavatories.
2. Kitchen Sinks.
3. Exam Room Sinks.
4. Faucets.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories, sinks, and faucets to include in operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.5 SPARE PARTS

- A. Furnish spare parts to the Engineer that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES

- A. Lavatory: Round, self-rimming, vitreous china, counter mounted.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Toto LT402#01, or an approved equal.
 - 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Self-rimming for above-counter mounting.
 - c. Nominal Size: Round, 19 inches
 - d. Faucet-Hole Punching: One hole
 - e. Faucet-Hole Location: Top.
 - f. Color: White
 - g. Mounting Material: Sealant.
 - 3. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece
 - 4. Supply Fittings: Chrome-plated copper with stops.
 - 5. Waste Fittings: Chrome-plated cast brass P-trap; 0.032-inch thick tubular brass waste to wall, and wall escutcheons.
 - 6. Protective Shielding Guards: As specified.

2.2 KITCHEN SINKS

- A. Kitchen Sinks: Stainless steel, under-mounted.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay ELUHAD281650, or an approved equal.
 - 2. Fixture:
 - a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
 - b. Type: Basin with radius corners, back for faucet, and support brackets.

- c. Nominal Size: 30-1/2 by 18-1/2 by 4-7/8 inches.
- 3. Drain: Grid type with offset as required and straight tailpiece.
- 4. Supply Fittings: Chrome-plated copper with stops.
- 5. Waste Fittings: Chrome-plated cast brass P-trap; 0.032-inch thick tubular brass waste to wall, and wall escutcheons.
- 6. Support: Under-mount brackets.

2.3 EXAM ROOM SINKS

A. Exam Room Sinks: Stainless steel, counter-mounted.

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay LR2521, or an approved equal.
- 2. Fixture:
 - a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
 - b. Type: Basin with radius corners, back for faucet, and support brackets.
 - c. Nominal Size: 25 by 21-1/4 by 7-7/8 inches.
- 3. Drain: Grid type with offset as required and straight tailpiece.
- 4. Supply Fittings: Chrome-plated copper with stops.
- 5. Waste Fittings: Chrome-plated cast brass P-trap; 0.032-inch thick tubular brass waste to wall, and wall escutcheons.
- 6. Support: As required

2.4 SOLID-BRASS, MANUALLY OPERATED FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets: Manual-type, single-control mixing, general-duty, solid-brass valve.

- 1. Lavatory Faucets shall be Pro1100 as manufactured by PurePro. No "Or Equals" will be considered.
- 2. Standards: ASME A112.18.1/CSA B125.1.
- 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
- 4. Body Type: Single hole
- 5. Body Material: Commercial solid brass.
- 6. Finish: Polished chrome plate
- 7. Maximum Flow Rate: 0.5 gpm
- 8. Mounting Type: Deck, exposed.
- 9. Valve Handle(s): Single lever, 6 inches.

10. Spout: Rigid type.
 11. Spout Outlet: Aerator.
 12. Operation: Compression, manual.
 13. Drain: Grid.
- C. Exam Room and Kitchen Sink Faucets: Manual-type, single-control mixing, general-duty, solid-brass valve.
1. Basis-of-Design Product: Subject to compliance with requirements, Elkay Avado LKAV1031, or an approved equal.
 2. Standard: ASME A112.18.1/CSA B125.1.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 4. Body Type: Single Hole
 5. Body Material: Commercial, solid brass
 6. Finish: Polished chrome plate.
 7. Maximum Flow Rate: 1.5 gpm.
 8. Mixing Valve: Single control.
 9. Mounting: As required.
 10. Handle(s): Lever.
 11. Spout Type: Swivel, gooseneck
 12. Vacuum Breaker: Required for hose outlet
 13. Spout Outlet: Aerator.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install accessible wall-mounted fixtures at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install water-supply piping with stop on each supply to each sink faucet.

1. Exception: Use ball valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."
 2. Install stops in locations where they can be easily reached for operation.
- E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
 - F. Seal joints between fixtures, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
 - G. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible fixtures. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories, sinks, and fittings.

- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216

SECTION 224713 – DRINKING FOUNTAINS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes drinking fountains and related components.
- B. The Contractor shall salvage the existing drinking fountains.**

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of pressure water cooler.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Spare Parts: Include name, address, and telephone number of in-state supplier of spare parts. No out-of-state suppliers shall be permitted.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For drinking fountains to include in operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 SPARE PARTS:

- A. Furnish to the Engineer spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Water Filter Cartridges: Equal to 200% of amount installed for each type and size indicated.

PART 2 - PRODUCTS

2.1 DRINKING FOUNTAINS:

A. Drinking Fountains: Wall mounted, wheelchair accessible.

1. Basis-of-Design: 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. Elkay Manufacturing Co; Model No. LZSG8WSLK.
2. Cabinet: Single, vinyl-covered steel with stainless-steel top, with bottle filling station.
3. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
4. Control: Electronic Bottle Filler Sensor, Mechanical front button
5. Drain: Grid with NPS 1-1/4 tailpiece.
6. Supply: NPS 3/8 with shutoff valve.
7. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
8. Filter: As specified herein.
9. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - 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.
10. Capacities and Characteristics:
 - a. Cooled Water: 8 gph.
 - b. Ambient-Air Temperature: 90 deg F.
 - c. Inlet-Water Temperature: 80 deg F.
 - d. Cooled-Water Temperature: 50 deg F.
 - e. Electrical Characteristics:
 - 1) Motor Horsepower: 1/5.
 - 2) Volts: 120-V ac.
 - 3) Phase: Single.
 - 4) Hertz: 60.
11. Support: ASME A112.6.1M, Type I water-cooler carrier.

2.2 WATER FILTERS:

- A. Water Filters: Water Filters shall be Model 3US-AS01 as manufactured by Filtrete. No "Or Equals" will be considered.
- B. Filter-Mounting Type: Housing head section with threaded inlet and outlet, mounting bracket for installation adjacent to the drinking fountains.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls and floors for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fixtures level and plumb according to roughing-in drawings.
- B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install accessible wall-mounted fixtures at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Section 220523 "General-Duty Valves for Plumbing Piping."
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Install ball, gate, or globe shutoff valve on water supply to each fixture. Comply with valve requirements specified in Section 220523 "General-Duty Valves for Plumbing Piping."
- D. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

- A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.
- C. Provide protective covering for installed fixtures.
- D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224713

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Sleeves.
2. Sleeve-seal systems.
3. Stack-sleeve fittings.
4. Sleeve-seal systems.
5. Sleeve-seal fittings.
6. Grout.
7. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Fire stopping" for penetration fire stopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES:

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends and integral welded waterstop collar.
- D. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- G. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms

2.2 STACK-SLEEVE FITTINGS

- A. Description: Manufactured, galvanized cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS:

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. CALPICO, Inc.
 - 2. Metraflex Company (The).
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633 of length required to secure pressure plates to sealing elements.
 - 4. Designed to form a hydrostatic seal of 20-psig minimum.
 - 5. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.

2.4 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C 920, Type S, Grade NS, Class 25, use NT.
- B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
- C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION:

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 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.
 - 2. Using silicon sealing, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in CSI Division 07 Section 079200, "Joint Sealants."

- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in CSI Division 07 Section 078413, "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.
- B. Fire-Resistance-Rated, Horizontal Assembly, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION:

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings as new walls and slabs are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using silicone sealant, seal space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE:

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves.
 - b. Piping NPS 6 and Larger: Cast-iron wall sleeves.
 - 2. Exterior Concrete Walls below Grade:
 - a. Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 3. Concrete Slabs-on-Grade:
 - a. Cast-iron wall sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping NPS 6 (and larger: Steel pipe sleeves with sleeve-seal system).
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
 - 4. Concrete Slabs Above Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Steel pipe sleeves.
 - 5. Interior Partitions:

- a. Galvanized-steel-pipe sleeves.
- b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

3.6 GROUT:

- A. Refer to CSI Division 03 Section 033000, “Cast in Place Concrete” for non-shrink grout.
- B. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- C. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- D. Design Mix: 5000-psi, 28-day compressive strength.
- E. Packaging: Premixed and factory packaged.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.
- C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for Piping and Relocated Existing Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece steel with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
 - d. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
 - e. Insulated Piping: One-piece cast brass with polished, chrome-plated finish.
 - f. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - g. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - h. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - i. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - j. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - k. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - l. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
 - m. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - n. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - o. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
 - p. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.

- q. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - r. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
 - s. Bare Piping in Equipment Rooms: One-piece cast brass with polished, chrome-plated] finish.
 - t. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
2. Escutcheons for Existing Piping to Remain:
- a. Chrome-Plated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping and Relocated Existing Piping: Split floor plate.
 - 2. Existing Piping to Remain: Split floor plate.

3.2 FIELD QUALITY CONTROL

- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 230518

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

1.1 SUMMARY:

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Filled-system thermometers.
7. Liquid-in-glass thermometers.
8. Light-activated thermometers.
9. Duct-thermometer mounting brackets.
10. Sight flow indicators.
11. Flowmeters.
12. Thermal-energy meters.

1.2 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.
- C. Shop Drawings:
 1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS:

- A. Quality Assurance Submittals:
 1. Product Certificates: For each type of meter and gage, from manufacturer.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals specified in Form 817 Section 1.20-1.08.14 subsection 2 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS:

- 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. Terrice, H. O. Co.
 - 2. Weiss Instruments, Inc.
 - 3. Weksler Glass Thermometer Corp.
- B. Standard: ASME B40.200.
- C. Case: Sealed type; stainless steel with 5-inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings.
- E. Connector Type: Union joint, adjustable angle, with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1 percent of scale range.

2.2 THERMOWELLS:

- A. Thermowells:
 - 1. Manufacturers: Same as manufacturer of thermometer being used.
 - 2. Standard: ASME B40.200.
 - 3. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - 4. Material for Use with Copper Tubing: CNR or CUNI.
 - 5. Material for Use with Steel Piping: CRES or CSA.

6. Type: Stepped shank unless straight or tapered shank is indicated.
7. External Threads: For insertion in a pipe fitting, ASME B1.20.1 pipe threads.
8. Internal Threads: To match thermometer connector threads, with ASME B1.1 screw threads.
9. Bore: Diameter required to match thermometer bulb or stem.
10. Insertion Length: Length required to match thermometer bulb or stem.
11. Lagging Extension: Include on thermowells for insulated piping and tubing.
12. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES:

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

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. Terrice, H. O. Co.
 - b. Weiss Instruments, Inc.
 - c. Weksler Glass Thermometer Corp.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings.
8. Pointer: Dark-colored metal.
9. Window: Glass or plastic.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS:

- A. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS:

- 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. Sisco Manufacturing Company, Inc.
 - 2. Trerice, H. O. Co.
 - 3. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 , ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Self-sealing rubber.
 - 1. Insert material for water service at 20 to 200 deg F shall be chlorosulfonated polyethylene synthetic.
 - 2. Insert material for water service at minus 30 to plus 275 deg F shall be EPDM.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install test plugs in piping tees.
- I. Install thermometers in the following locations:
 - 1. Return from each hydronic zone.
- J. Install pressure gages in the following locations:
 - 1. Suction and discharge of each pump.

3.2 CONNECTIONS:

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING:

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE:

- A. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F with 2-degree scale divisions.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE:

- A. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi.

END OF SECTION 230519

SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Bronze ball valves.
2. Iron, single-flange butterfly valves.
3. Bronze swing checks valves.
4. Iron swing check valves.
5. Iron, plate-type check valves.

B. Related CSI Sections:

1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section 230553, "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.2 DEFINITIONS:

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of valve indicated.

1.4 INFORMATIONAL SUBMITALLS:

- A. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Refer to Form 817 Article 1.20-1.06.03 for additional information.
- B. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
 - 4. Set butterfly valves closed or slightly open.
 - 5. Block check valves in either closed or open position.
- C. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES:

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer in accordance with Form 817 Article 1.20-1.06.01.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B16.18 for solder-joint connections.
 - 5. ASME B31.1 for power piping valves.
 - 6. ASME B31.9 for building services piping valves.
- C. Refer to Part 3 HVAC valve schedule articles for applications of valves.
- D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Actuator Types:
 - 1. Handwheel: For valves other than quarter-turn types.
 - 2. Vinyl-Covered Handlever: For quarter-turn valves.

G. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES:

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

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. Conbraco Industries, Inc.
 - b. Crane; Crane Energy Flow Solutions.
 - c. NIBCO INC.
 - d. Watts; a Watts Water Technologies company.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES:

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:

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. Conbraco Industries, Inc.
 - b. NIBCO INC.

- c. Watts; a Watts Water Technologies company.
2. Description:
- a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
 - e. Seat: EPDM.
 - f. Stem: One- or two-piece stainless steel.
 - g. Disc: Aluminum bronze.

2.4 BRONZE SWING CHECK VALVES:

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

- 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. Crane; Crane Energy Flow Solutions.
 - b. NIBCO INC.
 - c. Watts; a Watts Water Technologies company.
- 2. Description:
 - a. Standard: MSS SP-80, Type 4.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: PTFE.

2.5 IRON SWING CHECK VALVES:

A. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

- 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. Crane; Crane Energy Flow Solutions.
 - b. Stockham; Crane Energy Flow Solutions.
- 2. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 6, CWP Rating: 200 psig.
- c. Body Design: Clear or full waterway.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Composition.
- g. Seat Ring: Bronze.
- h. Disc Holder: Bronze.
- i. Disc: PTFE.
- j. Gasket: Asbestos free.

2.6 IRON, PLATE-TYPE CHECK VALVES:

A. Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:

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. Crane; Crane Energy Flow Solutions.
 - b. NIBCO INC.
 - c. Sure Flow Equipment Inc.
 - d. Watts; a Watts Water Technologies company.
2. Description:
 - a. Standard: API 594.
 - b. NPS 2-1/2 to NPS 6, CWP Rating: 200 psig.
 - c. Body Design: Wafer, spring-loaded plates.
 - d. Body Material: ASTM A 126, gray iron.
 - e. Seat: EPDM.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.

- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION:

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Plate-Type Check Valves: In horizontal or vertical position, between flanges.

3.3 ADJUSTING:

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS:

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball or butterfly valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service: Ball or butterfly valves.
 - 4. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
 - b. NPS 2-1/2 and Larger: Iron swing check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 HEATING-WATER VALVE SCHEDULE:

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with bronze trim.
3. Bronze Swing Check Valves: Class 125 nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 6: 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
4. Iron, Plate-Type Check Valves: Class 125; single or dual plate; resilient seat.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Steel pipe hangers and supports.
2. Trapeze pie hangers.
3. Thermal-hanger shield inserts.
4. Fastener systems
5. Metal framing systems.
6. Pipe stands.
7. Equipment supports.

B. Related CSI Sections:

1. Division 05 Section 055000, "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 Section 211313, "Wet Pipe Sprinkler Systems" for pipe hangers for fire-suppression piping.
3. Division 23 Section 230516, "Expansion Fittings and Loop for HVAC Piping" for pipe guides and anchors.
4. Division 23 Section 230548, "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
5. Division 23 Section 233113, "Metal Ducts" for duct hangers and supports.

1.2 DEFINITIONS:

- ##### A. Terminology:
- As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports," Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.3 PERFORMANCE REQUIREMENTS:

- ##### A. Delegated Design:
- Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- ##### B. Structural Performance:
- Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.4 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail fabrication and assembly of trapeze hangers.
 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS:

- A. Quality Assurance Submittals:
 1. Welding certificates.

1.6 QUALITY ASSURANCE:

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS:

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
- B. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
- C. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

- E. 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 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:

1. From the selection please select three (3) manufacturers.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturred lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Hot-dipped galvanized.
8. Paint Coating: Acrylic.
9. Plastic Coating: PVC.

- B. Non-MFMA Manufacturer Metal Framing Systems:

1. From the selection please select three (3) manufacturers.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with unturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: PVC.

2.4 THERMAL-HANGER SHIELD INSERTS:

- A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.

- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 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 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.

2.6 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 2. Base: Plastic.
 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 2. Bases: One or more; plastic.

3. Vertical Members: Two or more protective-coated-steel channels.
 4. Horizontal Member: Protective-coated-steel channel.
 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION:

- A. Steel Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly supporting piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricates from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.
- I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. 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.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. 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.
- O. Insulated Piping:
 - 1. Attach clamps and spacers to piping.

- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 5. Insert Material: Length at least as long as protective shield.
 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports

3.3 METAL FABRICATIONS:

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING:

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING:

- A. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- 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 CSI 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. Use padded hangers for piping that is subject to scratching.

- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 6.
 - 2. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 6, from two rods if longitudinal movement caused by expansion and contraction might occur.
 - 3. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 6, from single rod if horizontal movement caused by expansion and contraction might occur.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 6.
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 6 if longer ends are required for riser clamps.
- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 - 3. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 - 2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 3. C-Clamps (MSS Type 23): For structural shapes.
 - 4. 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.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
- N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- O. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes vibration and seismic controls for HVAC piping and equipment.
- B. Related CSI Requirements:
 - 1. Division 22 Section 220548 “Vibration and Seismic Controls for Plumbing” for devices for plumbing equipment systems.

1.2 DEFINITIONS:

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

1.3 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 - 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including

analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other CSI Division 23 Sections for equipment mounted outdoors.
2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.
3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
4. Seismic- and Wind-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other CSI Division 23 Sections for equipment mounted outdoors.
 - d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS:

A. Quality Assurance Submittals:

1. Qualification Data: For professional engineer and testing agency.
2. Welding certificates.
3. Field quality-control test reports.

1.5 QUALITY ASSURANCE:

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS:

- A. Wind-Restraint Loading:
 - 1. Basic Wind Speed: 100 mph.
 - 2. Building Classification Category: IV.
 - 3. Minimum 10 lb/sq. ft. multiplied by the maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.
- B. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV.
 - a. Seismic Design Category: C.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second)(S_{DS}): 0.182.
 - 4. Design Spectral Response Acceleration at 1.0-Second Period S_{D1} : 0.064.

2.2 ELASTOMERIC ISOLATION PADS:

- A. Elastomeric Isolation Pads:

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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Isolation.
 - h. Vibration Mountings & Controls, Inc.
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Load-bearing metal plates adhered to pads.

2.3 ELASTOMERIC ISOLATION MOUNTS:

A. Double-Deflection, Elastomeric Isolation Mounts:

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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Isolation.
 - h. Vibration Mountings & Controls, Inc.
2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS:

A. Restrained Elastomeric Isolation Mounts:

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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Isolation.
 - h. Vibration Mountings & Controls, Inc.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 OPEN-SPRING ISOLATORS:

A. Freestanding, Laterally Stable, Open-Spring Isolators:

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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Isolation.
 - h. Vibration Mountings & Controls, Inc.
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. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.6 RESTRAINED-SPRING ISOLATORS:

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Isolation.
 - h. Vibration Mountings & Controls, Inc.
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes or elastomeric pad.
3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.7 PIPE-RISER RESILIENT SUPPORT:

- ### A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.8 RESILIENT PIPE GUIDES:

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- thick neoprene.
 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.9 ELASTOMERIC HANGERS:

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
 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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Isolation Technology, Inc.
 - d. Kinetics Noise Control, Inc.
 - e. Mason Industries, Inc.
 - f. Vibration Eliminator Co., Inc.
 - g. Vibration Mountings & Controls, Inc.
 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.10 SPRING HANGERS:

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
 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. Ace Mountings Co., Inc.
 - b. California Dynamics Corporation.
 - c. Kinetics Noise Control, Inc.
 - d. Mason Industries, Inc.
 - e. Vibration Eliminator Co., Inc.
 - f. Vibration Isolation.
 - g. Vibration Mountings & Controls, Inc.
2. 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.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
 8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
 9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.11 SNUBBERS:

- 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. Kinetics Noise Control, Inc.
 2. Mason Industries, Inc.
 3. Vibration Mountings & Controls, Inc.
- B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

2.12 RESTRAINT CHANNEL BRACINGS:

- 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. Cooper B-Line, Inc.
 - 2. Hilti, Inc.
 - 3. Mason Industries, Inc.
 - 4. Unistrut.
- B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.13 RESTRAINT CABLES:

- 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. Kinetics Noise Control, Inc.
 - 2. Loos & Co., Inc.
 - 3. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: ASTM A 603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.14 SEISMIC-RESTRAINT ACCESSORIES:

- 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. Cooper B-Line, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
 - 4. TOLCO.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod.
- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.15 MECHANICAL ANCHOR BOLTS:

- 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. Cooper B-Line, Inc.
 - 2. Hilti, Inc.
 - 3. Kinetics Noise Control, Inc.
 - 4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.16 ADHESIVE ANCHOR BOLTS:

- 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. Hilti, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.17 VIBRATION ISOLATION EQUIPMENT BASES:

- 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. California Dynamics Corporation.
 - 2. Kinetics Noise Control.
 - 3. Mason Industries, Inc.
 - 4. Vibration Eliminator Co., Inc.
 - 5. Vibration Isolation.
 - 6. Vibration Mountings & Controls, Inc.

- B. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

- C. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.18 RESTRAINED ISOLATION ROOF-CURB RAILS:

- 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. Ace Mountings Co., Inc.
 - 2. California Dynamics Corporation.
 - 3. Kinetics Noise Control.
 - 4. Mason Industries, Inc.
 - 5. Thybar Corporation.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.
- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS:

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION:

- A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- B. Comply with requirements in CSI Division 07 Section 077200 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- C. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- D. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. 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.
- I. 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.
- J. Drilled-in Anchors:
 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. 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 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION:

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in CSI Divisions 23 Section 232113 "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL:

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with the Engineer, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by the Engineer.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING:

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 HVAC VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Supported Equipment: Rooftop Unit.

1. Equipment Location: Outdoor.
2. Type: Restrained Vibration Isolation Roof Curb Rails.
3. Minimum Deflection: As required.
4. Component Importance Factor: 1.5.
5. Component Response Modification Factor: 2.5.
6. Component Amplification Factor: 2.5.

B. Supported Equipment: Boilers.

1. Equipment Location: Mechanical Room.
2. Pads:
 - a. Material: Neoprene, Rubber, or Hermetically sealed compressed fiberglass.
 - b. Thickness: As required.
 - c. Number of Pads: As required.
3. Mount: Elastomeric.
4. Base Type: As required.
5. Minimum Deflection: As required.
6. Component Importance Factor: 1.5.
7. Component Response Modification Factor: 2.5.
8. Component Amplification Factor: 1.0.

C. Supported Equipment: Condenser/Floor-Mounted Boiler Expansion Tank.

1. Equipment Location: Outdoor/Mechanical Room.
2. Type: As required.
3. Minimum Deflection: As required.
4. Component Importance Factor: 1.5.
5. Component Response Modification Factor: 2.5.
6. Component Amplification Factor: 2.5.

D. Supported Equipment: Hydronic Pumps, Suspended Fans, Propeller and Cabinet Unit Heaters.

1. Equipment Location: Various.
2. Isolator Type: Elastomeric Hangers, Spring Hangers, or Spring Hangers with Vertical-Limit Stop.
3. Minimum Deflection: As required.
4. Component Importance Factor: 1.5.
5. Component Response Modification Factor: 2.5.
6. Component Amplification Factor: 1.0.

E. Supported Equipment: Chimneys.

1. Equipment Location: Mechanical Room.
2. Type: As required.
3. Minimum Deflection: As required.
4. Component Importance Factor: 1.5.
5. Component Response Modification Factor: 2.5.
6. Component Amplification Factor: 1.0.

F. Piping Systems, NPS 2 1/2 and larger: Hydronic, Natural Gas.

1. Type: As required.

2. Minimum Deflection: As required.
3. Component Importance Factor: 1.5.
4. Component Response Modification Factor: 2.5.
5. Component Amplification Factor: 1.0.

G. Piping Systems, NPS 2 and smaller: Hydronic, Natural Gas, Refrigerant.

1. Not Required.

H. Ducts.

1. Type: As required.
2. Minimum Deflection: As required.
3. Component Importance Factor: 1.5.
4. Component Response Modification Factor: 6.0.

END OF SECTION 230548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Valve tags.
6. Warning tags.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
- C. Samples: For color, letter style, and graphic representation required for each identification material and device.
- D. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- E. Valve numbering scheme.
- F. Valve Schedules: For each piping system to include in maintenance manuals. Refer to Form 817 Article 1.20-1.08.14 subsection 2 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: Black.

3. Background Color: Yellow.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: Yellow.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.

- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: Yellow.

- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.5 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet 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.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
1. Chilled-Water Piping: Black letters on a safety-orange background.
 2. Condenser-Water Piping: Black letters on a safety-orange background.
 3. Heating Water Piping: White letters on a safety-green background.
 4. Refrigerant Piping: White letters on a safety-purple background.

3.5 DUCT LABEL INSTALLATION

- A. Install plastic-laminated self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
 2. Yellow: For hot-air supply ducts.
 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
- B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
 - a. Chilled Water: 1-1/2 inches round.
 - b. Condenser Water: 1-1/2 inches round.
 - c. Refrigerant: 1-1/2 inches round.
 - d. Hot Water: 1-1/2 inches round.
 2. Valve-Tag Colors:

- a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
- b. Flammable Fluids: Black letters on a safety-yellow background.
- c. Combustible Fluids: White letters on a safety-brown background.
- d. Potable and Other Water: White letters on a safety-green background.
- e. Compressed Air: White letters on a safety-blue background.
- f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes testing, adjusting, and balancing for HVAC to produce design objectives.

1.2 DEFINITIONS:

- A. AABC: Associated Air Balance Council
- B. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- C. Balance: To proportion flows within the distributed system, including submains, branches, and terminals, according to indicated design quantities
- D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- E. NEBB: National Environmental Balancing Bureau.
- F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- G. Report Forms: Test data sheets for recording test data in a logical order.
- H. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
- I. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- J. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- K. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
- L. TAB: Testing, adjusting, and balancing.

- M. TABB: Testing, Adjusting, and Balancing Bureau.
- N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- O. Test: A procedure to determine quantitative performance of systems or equipment.
- P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.3 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

1.4 INFORMATIONAL SUBMITTALS:

- A. Qualification Data: Submit copies of current valid certificates to show that the TAB firm and TAB supervisor meet the qualifications specified in Part 1.5 "Quality Assurance". This data shall be submitted a minimum of 30 calendar days before the Contractor's schedule anticipates the commencement of TAB work.
- B. Contract Documents Examination Report: Submit the Contract Documents review report as specified in Part 3.1 "Examination" a minimum of 30 calendar days before the Contractor's schedule anticipates the commencement of TAB work.
- C. Strategies and Procedures Plan: Submit TAB strategies and step-by-step procedures and system readiness reports as specified in Part 3.2 "Preparation" a minimum of 30 calendar days before the Contractor's schedule anticipates the commencement of TAB work. Include a complete set of report forms intended for use on this Project.
- D. Certified TAB reports. Submit reports prepared, as specified in this Section, on approved forms certified by TAB firm.
 - 1. Reports shall bear the seal and signature of the certified supervisor.
 - 2. Final Report shall be submitted a minimum of 14 calendar days' before the anticipated "Semi Final Inspection" described in Form 816 Article 1.20-1.08.12 subsection 1.

1.5 QUALITY ASSURANCE:

- A. TAB Firm Qualifications: Engage a TAB entity certified by AABC, NEBB, or TABB with AABC, NEBB, or TABB certified supervisors.
- B. Conduct a TAB Meeting at the Project Site in compliance with the requirements of Form 816 Article 1.20-1.05.24 subsection 2.

1. Meet with Engineer’s representatives on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of the Contractor, TAB team members, equipment manufacturers’ authorized service representatives, HVAC controls installers, and other support personnel. Provide seven calendar days’ advance notice of scheduled meeting time and location.
 2. Agenda Items:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. The TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 2. Certify that the TAB firm complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard forms from AABC’s “National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems,” NEBB’s “Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems,” or SMACNA’s “HVAC Systems – Testing Adjusting and Balancing.”
- E. Instrumentation Type, Quantity, Accuracy: As described in AABC’s “National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems,” NEBB’s “Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Section II, Required Instrumentation for NEBB Certification or ASHRAE 111, Section 5, "Instrumentation."
- F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.
- 1.6 PROJECT CONDITIONS:
- A. Systems Operation: All building mechanical systems, including BAS/ATC System, shall be complete and fully operational prior to beginning balancing procedures.

1.7 COORDINATION:

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven calendar days' advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

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.
 - 1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- B. Examine the approved submittals for HVAC systems and equipment.
- C. 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.
- D. Examine system and equipment installations and verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual CSI Sections have been performed.

- 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 system and equipment test reports.
- G. Examine HVAC system and equipment installations to verify that indicated balancing devices such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- H. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- I. Examine HVAC equipment to ensure that clean air filters have been installed, bearings are greased, belts are aligned and tight, 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 for clean screens and proper perforations.
- L. Examine three-way valves for proper installation for their intended function of 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 equipment for installation and properly operating safety interlocks and controls on HVAC equipment.
- P. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Temperature sensors and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.

7. Sequence of operation for control modes is according to the Contract.
8. Controller set points are set at indicated design values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated design values.

Q. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated design values.

3.2 PREPARATION:

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

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. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
- b. Duct systems are complete with terminals installed.
- c. Volume, smoke, and fire dampers are open and functional.
- d. Clean filters are installed.
- e. Fans are operating, free of vibration, and rotating in correct direction.
- f. Variable-frequency controllers' startup is complete and safeties are verified.
- g. Automatic temperature-control systems are operational.
- h. Ceilings are installed.
- i. Windows and doors are installed.
- j. 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. Systems are flushed, filled, and air purged.
- d. Strainers are pulled and cleaned.
- e. Control valves are functioning per the sequence of operation.
- f. Shutoff and balance valves have been verified to be 100 percent open.
- g. Variable-frequency controllers' startup is complete and safeties are verified.
- h. 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," ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specification for this Project.
- 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. Crosscheck 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 CSI Division 23 Section 233113, "Metal Ducts."

3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS:

- A. Adjust the variable-air-volume systems as follows:
 - 1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
 - 2. Verify that the system is under static pressure control.
 - 3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:
 - a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
 - b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
 - c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
 - d. Adjust controls so that terminal is calling for minimum airflow.
 - e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
 - f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
 - g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.
 - 5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.

- c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
6. 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 any artificial loading of filters at the time static pressures are measured.
7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
- a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
 - b. Verify that terminal units are meeting design airflow under system maximum flow.
8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:
- a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - b. Re-measure and confirm that total airflow is within design.
 - c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
 - d. Mark final settings.
 - e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
 - f. Verify tracking between supply and return fans.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS:

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.
 2. Check liquid level in expansion tank.
 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation, and set at indicated design flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 7. Check air vents for a forceful liquid flow exiting from vents when manually operated.

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
 2. 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 MOTORS:

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.

3.9 PROCEDURES FOR CONDENSING UNITS:

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS:

- A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.11 TOLERANCES:

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.12 REPORTING:

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend

changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

3.13 FINAL REPORT:

- A. General: Prepare a certified report in letter-quality font on standard bond paper, in three ring binder. 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.
- 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 in the final report, as applicable:
 - 1. Title page.
 - 2. Name and address of the TAB firm.
 - 3. Project name.
 - 4. Project location.
 - 5. Designer's name and address.
 - 6. Contractor's name and address.
 - 7. Report date.
 - 8. Signature of certified supervisor of TAB firm who certifies the report.
 - 9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 10. Summary of contents including the following:
 - a. Indicated design versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 11. Nomenclature sheets for each item of equipment.
 - 12. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 13. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 14. 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. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
- 1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 - 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, and bore.

- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
3. Test Data (Indicated Design and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Cooling-coil static-pressure differential in inches wg.
 - g. Heating-coil static-pressure differential in inches wg.
 - h. Outdoor airflow in cfm.
 - i. Return airflow in cfm.
 - j. Outdoor-air damper position.
 - k. Return-air damper position.
- F. 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 Design and Actual Values):
 - a. Air flow 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.
- 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, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - 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, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated Design and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- H. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
- 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated design air flow rate in cfm.
 - h. Indicated design velocity in fpm.

- i. Actual air flow rate in cfm.
- j. Actual average velocity in fpm.
- k. Barometric pressure in psig.

I. 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.

2. Test Data (Indicated Design and Actual Values):

- a. Air flow rate in cfm.
- b. Air velocity in fpm.
- c. Preliminary air flow rate as needed in cfm.
- d. Preliminary velocity as needed in fpm.
- e. Final air flow rate in cfm.
- f. Final velocity in fpm.
- g. Space temperature in deg F.

J. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, or air-cooled condensing units, include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Unit make and model number.
- d. Compressor make.
- e. Compressor model and serial numbers.
- f. Refrigerant weight in lb.
- g. Low ambient temperature cutoff in deg F.

2. Test Data (Indicated Design and Actual Values):

- a. Inlet-duct static pressure in inches wg.
- b. Outlet-duct static pressure in inches wg.
- c. Entering-air, dry-bulb temperature in deg F.
- d. Leaving-air, dry-bulb temperature in deg F.
- e. Condenser entering-water temperature in deg F.

- f. Condenser leaving-water temperature in deg F.
- g. Condenser-water temperature differential in deg F.
- h. Condenser entering-water pressure in feet of head or psig.
- i. Condenser leaving-water pressure in feet of head or psig.
- j. Condenser-water pressure differential in feet of head or psig.
- k. Control settings.
- l. Unloader set points.
- m. Low-pressure-cutout set point in psig.
- n. High-pressure-cutout set point in psig.
- o. Suction pressure in psig.
- p. Suction temperature in deg F.
- q. Condenser refrigerant pressure in psig.
- r. Condenser refrigerant temperature in deg F.
- s. Oil pressure in psig.
- t. Oil temperature in deg F.
- u. Voltage at each connection.
- v. Amperage for each phase.
- w. Kilowatt input.
- x. Crankcase heater kilowatt.
- y. Number of fans.
- z. Condenser fan rpm.
- aa. Condenser fan airflow rate in cfm.
- bb. Condenser fan motor make, frame size, rpm, and horsepower.
- cc. Condenser fan motor voltage at each connection.
- dd. Condenser fan motor amperage for each phase.

K. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btu/h.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.

- d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- L. 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.
 - b. Entering-water temperature in deg F.
 - c. Leaving-water temperature in deg F.
 - d. Water pressure drop in feet of head or psig.
 - e. Entering-air temperature in deg F.
 - f. Leaving-air temperature in deg F.
- M. Instrument Calibration Reports:
- 1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.14 ADDITIONAL TESTS

- A. Within 240 calendar days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
 - 1. Additional testing shall be performed during the opposite weather season to the greatest extent possible
 - 2. The Contractor shall submit to the Designer its additional testing schedule for approval.

- 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 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY:

- A. Section Includes: HVAC duct insulation and accessories.
- B. Related CSI Sections:
 - 1. Division 23 Section 230719, "HVAC Piping Insulation."
 - 2. Division 23 Section 233113 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- C. Sustainable Design Submittals:
- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.
- E. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
 - 1. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.3 INFORMATIONAL SUBMITTALS:

- A. Quality Assurance Submittals:

1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.
2. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.4 QUALITY ASSURANCE:

- A. Source Limitations: Obtain plumbing and HVAC insulation from a single manufacturer in accordance with Form 817 Article 1.20-1.06.01.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less, or FM Approved Class I materials.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 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.

1.6 COORDINATION:

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in CSI Division 23 Section 230529, "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and for space required for maintenance.

1.7 SCHEDULING:

- A. Schedule insulation application after pressure testing systems. 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 Duct Insulation Schedules 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. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2.5, "Factory-Applied Jackets".
 - 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.

2.2 ADHESIVES:

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS:

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
 1. Products: Subject to compliance with requirements, 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.

2.4 SEALANTS:

- A. Joint Sealants:
 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Permanently flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 4. Color: White or gray.
- B. FSK Flashing Sealants:
 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. Eagle Bridges - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - d. Mon-Eco Industries, Inc.; 44-05.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 3. Fire- and water-resistant, flexible, elastomeric sealant.
 - 4. Service Temperature Range: Minus 40 to plus 250 deg F.
 - 5. Color: Aluminum.
 - 6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 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-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; 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.

2.6 TAPES:

- A. 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.
- B. 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.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.7 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.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Insulation Pins and Hangers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) AGM Industries, Inc.; CHP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

- D. Wire: 0.062-inch soft-annealed, stainless steel
 - 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. C & F Wire.

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.
- B. 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.

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 ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct 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. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

- H. Install insulation with least number of joints practical.
- I. 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.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. 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. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 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 duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. 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.

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.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in CSI Division 07 Section 078413, "Penetration Firestopping."

3.5 INSTALLATION OF MINERAL-FIBER INSULATION:

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
- 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 - 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 - 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 DUCT INSULATION SCHEDULE, GENERAL:

A. Ducts Requiring Insulation:

- 1. Indoor, supply.
- 2. Indoor, return.

B. Items Not Insulated:

- 1. Factory-insulated flexible ducts.
- 2. Flexible connectors.
- 3. Vibration-control devices.
- 4. Factory-insulated access panels and doors.
- 5. Exhaust ductwork.

3.7 INDOOR DUCT INSULATION SCHEDULE:

A. Round, supply-air duct insulation shall be the following:

- 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Round, return-air duct insulation shall be the following:

- 1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

C. Rectangular, supply-air duct insulation shall be the following:

- 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

D. Rectangular, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY:

- A. Section Includes: HVAC piping insulation systems.
 - 1. Condensate drains piping, indoors.
 - 2. Chilled-water and brine piping, indoors.
 - 3. Heating hot-water piping, indoors.
 - 4. Heating hot-water piping, indoors.
 - 5. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related CSI Sections:
 - 1. Division 22 Section 220719, "Plumbing Piping Insulation."
 - 2. Division 23 Section 230713, "Duct Insulation."

1.2 DEFINITIONS:

- A. ASJ: All Service Jacket
- B. SSL: Self Sealing Lap

1.3 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.

4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

D. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Quality Assurance Submittals:

1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.
2. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.5 QUALITY ASSURANCE:

A. Source Limitations: Obtain plumbing and HVAC insulation from a single manufacturer in accordance with Form 817 Article 1.20-1.06.01.

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, or FM Approved Class I materials.
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 CSI Division 23 Section 230529, "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING:

- A. Schedule insulation application after pressure testing systems. 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 for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. From the selection please select three (3) manufacturers:
 - A. Armacell
 - B. Certainteed
 - C. John Manville
 - D. Approved Equal
 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] [ASJ-SSL]: Comply with ASTM C 552, Type II, Class 2.
 7. Factory fabricates shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armacell LLC; AP Armaflex.
 - b. Certainteed.
 - c. Johns Manville.
 - d. Approcal Equal.
- H. 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. Johns Manville; Micro-Lok.
 - b. Amarcell.
 - c. Certainteed.
 - d. Approved Equal.
 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES:

A.

1. From the selection please select three (3) manufacturers:
 - A. Armacell
 - B. Certainteed
 - C. John Manville
 - D. Approved Equal

B. Mineral-Fiber, Preformed Pipe Insulation:

1. From the selection please select three (3) manufacturers:
 - A. Armacell
 - B. Certainteed
 - C. John Manville
 - D. Approved Equal
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - b. Eagle Bridges - Marathon Industries; 225.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - d. Mon-Eco Industries, Inc.; 22-25.
2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. PVC Jacket Adhesive: Compatible with PVC jacket.

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. Dow Corning Corporation; 739, Dow Silicone.
 - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

- c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Polyco VP Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS:

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Products: Subject to compliance with requirements, 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.

2.4 SEALANTS:

- A. Joint Sealants:
 - 1. Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
 - 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. ASJ and PVC Jacket Flashing Sealants:

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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 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-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.6 FIELD-APPLIED JACKETS:

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

- a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.7 TAPES:

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, 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. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABI, Ideal Tape Division; 370 White PVC tape.
 - b. Compac Corporation; 130.
 - c. Venture Tape; 1506 CW NS.
 2. Width: 2 inches.
 3. Thickness: 6 mils.
 4. Adhesion: 64 ounces force/inch in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch in width.

2.8 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.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.
 3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.
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. C & F Wire.

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 prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

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 4 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 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.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. 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 CSI Division 07 Section 078413, "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.5 GENERAL PIPE INSULATION INSTALLATION:

A. Requirements herein generally apply to all insulation materials except where more specific requirements are specified elsewhere in this Section.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be

easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. 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.
8. 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.

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. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
 4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
 1. Install mitered sections of pipe insulation.
 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 INSTALLATION OF MINERAL-FIBER INSULATION:

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.8 FIELD-APPLIED JACKET INSTALLATION:

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.9 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.

3.10 INDOOR PIPING INSULATION SCHEDULE:

A. Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 1-1/2 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inch thick.
 2. NPS 2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
- C. Refrigerant Suction and Hot-Gas Flexible Tubing:
1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1-1/2 inch thick.

3.11 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE:

- A. Refrigerant Suction and Hot-Gas Flexible Tubing:
1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE:

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Exposed, Wash Bay Only:
1. PVC 20 mils thick.

END OF SECTION 230719

SECTION 230900- INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 – GENERAL

1.01 Work Included:

- A. Building Management System (BMS) Contractor shall provide and install:
1. A fully integrated Building Automation System (BAS), incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems with open communications capabilities as herein specified.
 2. Complete temperature control system to be DDC with electric actuation as specified herein.
 3. All wiring, conduit, panels, and accessories for a complete operational system.
 4. BMS Contractor shall be responsible for all electrical work associated with the BMS.
 - a. Perform all wiring in accordance with all local and national codes.
 - b. Install all line voltage wiring, concealed or exposed, in conduit in accordance with the division 16 specifications, NEC and local building code.
 - c. Provide a maximum of 50 feet extension of 120 volt, 20 amp circuits and circuit breakers from Emergency power panels for all BMS equipment power. Provide and install local UPS Power supply for all BMS system panels and equipment.
 - d. Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers and operator's workstations.
 - e. All low voltage electrical control wiring throughout the building whether exposed or concealed shall be run in conduit in accordance with the Division 26 specifications, local building code and the NEC.
 - f. Provide all miscellaneous field device mounting and interconnecting wiring for all mechanical systems including Air Handling Units, Condensers, terminal units, Finned- Tube Radiation and control system
 - g. All systems requiring interlock wiring shall be hardwired interlocked and shall not rely on the BMS to operate.
 5. Provide open communications system. The system shall be an open architecture with the capabilities to support a multi-vendor environment. To accomplish this effectively, system shall be capable of utilizing

standard protocols as follows as well as be able to integrate third-party systems via existing vendor protocols.

- a. System shall be capable of high speed Ethernet communication using BACnet/IP and TCP/IP protocol.
 - b. System shall be capable of BACnet communication according to ANSI/ASHRAE 135-2004 or ANSI/ASHRAE 135-2008.
 - c. System shall be capable of OPC client communicating according to OPC Data Access 2.0
 - d. The system shall be capable of supporting both standard and vendor specific protocols to integrate a wide variety of third-party devices and legacy systems.
 - e. The intent is to either use the existing Apogee Database Server and Operator Workstations to communicate with control systems provided by other vendors. This allows the user to have a single seat from which to perform daily operation.
6. Provide hardware, software, and wiring to provide communication interfaces with each of the systems listed below.
- a. Computer Room Air Conditioning (CRAC)
 - b. Lighting Control System
 - c. Security and Access Control
 - d. Closed Circuit TV
 - e. Fire Alarm System
7. Provide system graphics for each controlled device and/or integrated systems as required by the owner. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.
8. Primary DDC panels as follows:
- a. Minimum one (1) BMS system Primary DDC panel per major equipment system. (Chiller Plant, Boiler Plant, AHU, etc.) The application specific controllers installed for the terminal units on a floor will be connected to the BMS panel controlling the AHU supplying the air to the zone.
 - b. It shall be acceptable to combine up to three (3) of the following mechanical equipment into one (1) Primary DDC panel:
 - 1) Exhaust Fans
 - 2) Standalone Supply Fans
 - 3) Package AC Units
 - c. It is acceptable to wire the following systems into any of the Primary DDC panels:

- 1) Miscellaneous alarm monitoring (i.e., ATS, leak, temperature, light, etc.).
 - d. Motors in motor control centers shall be controlled from the DDC controller associated with HVAC system. It shall not be acceptable to control all motors in a MCC from one DDC controller dedicated to the MCC. The intent of this specification is that the loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.
9. Stand-alone Application Specific Controllers (ASCs) for terminal equipment (VAV, and VAV units).

B. GENERAL PRODUCT DESCRIPTION

1. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer. The installing manufacturer shall certify in writing, that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision. Installing contractor shall be Siemens Industry, Inc.
2. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specifically for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
3. The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.
4. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control strategy, reporting, alarming and trending function, or any function at any operator interface device.

5. DDC Controllers shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC Controllers shall also be able to send alarm to multiple operator workstations without dependence upon a central or intermediate processing device.
6. DDC Controllers shall be able to assign password access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust or control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation or portable terminal. For example, all base building and all tenant points shall be accessible to any base building operators, but only certain base building and tenant points shall be accessible to tenant building operators. Passwords and priority levels for every point shall be fully programmable and adjustable.

1.02 Products Furnished but Not Installed Under This Section

A. Hydronic Piping:

1. Control Valves
2. Temperature Sensor Wells and Sockets
3. Flow Meters
4. Pressure Sensors

B. Duct-work Accessories:

1. Dampers
2. Airflow Stations
3. Terminal Unit Controls

1.03 Products Integrated To but Not Furnished or Installed Under This Section

1.04 Approved Control System Contractors and Managers

A. The following are the approved Control System Contractors and Manufacturers:

1. Siemens Industry, Inc. – Product Line: APOGEE Automation System (Existing Base Building and Basis of Design) Point of contact: Michael Garala, Mobile: 860-306-8381, Email: michael.garala@siemens.com

No “Or Equals” will be permitted.

1.05 Quality Assurance

- A. The BAS system shall be designed and installed, commissioned and serviced by factory trained personnel. BMS contractor shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. The BMS contractor shall provide full time, on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BMS. The Bidder shall be regularly engaged in the installation and maintenance of BMS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the installation and maintenance of BMS systems similar in size and complexity to this project.
- B. The BMS contractor shall maintain a service organization consisting of factory trained service personnel and provide a list of 10 projects, similar in size and scope to this project, completed within the last five years.
- C. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- D. All BAS peer-to-peer building controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX and be so listed at the time of bid. All field level controllers shall comply with UL Standard UL 864 category UUKL; and be so listed at the time of Bid.
- E. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
- F. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.
- G. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network. Compatibility shall be defined as the ability for any existing

field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

1.06 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 operator workstation (server and browser for Web-based systems).
 - 1. Configuration and Tuning Screens. Screens used for configuring, calibrating, or tuning points, control loops, and similar control logic shall automatically refresh within 6 seconds.
 - 2. Alarm Response Time. An object that goes into alarm shall be annunciated at the workstation within 15 seconds.
 - 3. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with the mechanical process under control.
 - 4. Performance. Programmable controllers shall be able to completely execute DDC control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
 - 5. Multiple Alarm Annunciations. Each workstation on the network shall receive alarms within 5 seconds of other workstations.

1.07 Submittals

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Shop Drawings.
- C. Submittal data shall consist of the following:
 - 1. Direct Digital Control System Hardware:
 - a. Complete bill of materials indicating quantity, manufacturer, model number, and relevant technical data of equipment to be used.

b. Manufacturer's description and technical data, such as product specification sheets, installation and maintenance instructions for items listed below and for relevant items not listed below:

- 1) Direct Digital Controllers (controller panels)
- 2) Transducers and transmitters
- 3) Sensors (including accuracy data)
- 4) Valves
- 5) Dampers
- 6) Relays and Switches
- 7) Control Panels
- 8) Power Supplies
- 9) Operator Interface Equipment

c. Wiring diagrams and layouts for each control panel. Show all termination numbers.

2. Central System Hardware and Software:

a. Complete bill of material indicating quantity, manufacturer, model number, and relevant technical data of equipment used.

b. Manufacturer's description and technical data such as product specifications for items listed below and for relevant items furnished under this contract not listed below:

- 1) Central Processing Unit (CPU)
- 2) Monitors
- 3) Keyboards
- 4) Power Supply
- 5) Battery Backup
- 6) Interface Equipment Between CPU and Control Panels
- 7) Operating System Software
- 8) Operator Interface Software
- 9) Color Graphic Software
- 10) Third-party Software

c. Schematic diagrams of all control, communication, and power wiring for central system installation. Show interface wiring to control system.

d. Provide a list of BMS point naming convention. Indicate the format, structure and standards of typical point names. The naming convention shall follow the "Global_Campus_Building_Area_Equipment_Function" format.

Provide a list of point names for typical equipment and functions with specific examples.

3. Controlled Systems:
 - a. Riser diagrams showing control network layout, communication protocol, and wire types.
 - b. Schematic diagram of each controlled system. Label control points with point names. Graphically show locations of control elements.
 - c. 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. Instrumentation list for each controlled system. List control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
 - e. Complete description of control system operation including sequences of operation. Include and reference schematic diagram of controlled system.
4. Description of process, report formats and checklists to be used in *Part 3 – Control System Demonstration and Acceptance* of this specification.
5. Contractor shall submit documentation in the following phased delivery schedule:
 - a. Valve and damper schedules
 - b. Point Naming Convention
 - c. Sample Graphics
 - d. System schematics, including:
 - 1) System Riser Diagrams
 - 2) Sequence of Operations
 - 3) Mechanical Control Schematics
 - 4) Electrical Wiring Diagrams
 - 5) Control Panel Layouts
 - 6) Product Specification Sheets
 - e. As-built drawings
- D. Project Record Documents: Submit three copies of record (as-built) documents upon completion of installation. Submittal shall consist of:

1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11 x 17 prints.
2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements listed in the *Control System Demonstration and Acceptance* section in PART 3 – EXECUTION of this specification.
3. Operation and Maintenance (O & M) Manual: Submit in accordance with Form 817 Article 1.20-1.08.14 subsection 2 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.
 - a. As-built versions of the submittal product data.
 - b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
 - c. Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.
 - d. Graphic files, programs, and database on electronic media.
 - e. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
 - f. Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
 - g. Licenses, guarantees, and warranty documents for equipment and systems.

1.08 Warranty

- A. Refer to Form 817 Article 1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional requirements.
- B. Warrant labor and materials for specified control system free from defects for a period of 12 months from the issuance of the Certificate of Compliance. Failures on control systems that include all computer equipment, transmission equipment and all sensors and control devices during warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.

Respond during normal business hours within 24 hours of Owner's warranty service request.

- C. If Engineer determines that equipment and systems operate satisfactorily at the end of final start-up, testing, and commissioning phase, Engineer will certify in writing that control system operation has been tested and accepted in accordance with the terms of this specification.
- D. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with the above-mentioned items. Do not install updates or upgrades without Owner's written authorization.
- E. Exception:
 - 1. Contractor shall not be required to warrant reused devices, except those that have been rebuilt or repaired. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of Engineer's acceptance.
 - 2. Contractor shall not be required to warrant systems, equipment and devices or software if the damages and/or failures were caused by lack of training, unauthorized use, negligence or deliberate action of other parties, or job site conditions.

1.09 Ownership of Proprietary Material

- A. Project specific software and documentation shall become Owner's property. This includes, but is not limited to:
 - 1. Graphics
 - 2. Record drawings
 - 3. Database
 - 4. Application programming code

PART 2 – PRODUCTS

2.01 Materials:

- A. All products used in this project installation shall be new and currently manufactured and shall have been applied in similar installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner

or Owner's representative. Spare parts shall be available for at least five years after completion of this contract.

2.02 Communication:

- A. The design of the BMS shall support networking of operator workstations and Building Controllers. The network architecture shall consist of two levels, an Ethernet based primary network for all operator workstations, servers, and primary DDC controllers along with secondary Field Level Networks for terminal equipment application specific controllers.
- B. Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control programs.
- C. Operator Workstation Communication:
 - 1. All color graphic operator workstations shall reside on the Ethernet network and the consoles shall be set up in a client/server configuration.
 - 2. The servers will act as the central database for system graphics and databases to provide consistency throughout all system workstations.
 - 3. The network shall allow concurrent use of multiple BMS software site licenses.
- D. Workstation Level Network Communication
 - 1. All PCs shall simultaneously direct connect to the Ethernet Management Level Network without the use of an interposing device.
 - 2. Operator Workstation shall be capable of simultaneous direct connection and communication with BACnet/IP, OPC and TCP/IP corporate level networks without the use of interposing devices.
 - 3. The Management Level Network shall not impose a maximum constraint on the number of operator workstations.
 - 4. Any controller residing on the primary building level networks shall connect to Ethernet network without the use of a PC or a gateway with a hard drive.
 - 5. Any PC on the Management Level Network shall have transparent communication with controllers on the building level networks connected via Ethernet.

6. Any break in Ethernet communication from the PC to the controllers on the building level networks shall result in a notification at the PC.
7. The standard client and server workstations on the Management Level Network shall reside on industry standard Ethernet utilizing standard TCP/IP, IEEE 802.3.
8. System software applications will run as a service to allow communication with Primary Network Controllers without the need for user log in. Closing the application or logging off shall not prevent the processing of alarms, network status, panel failures, and trend information.
9. Any break in Ethernet communication between the standard client and server workstations on the Management Level Network shall result in a notification at each workstation.
10. Access to the system database shall be available from any standard client workstation on the Management Level Network.
11. Client access to client-server workstation configurations over the Internet network shall be available via Web browser interface.
12. Client access to client-server workstation configurations over the Intranet or Internet shall be available via 3 client options:
 - a. Web Browser. Client runs in a browser as a Full Trust client application.
 - b. Dedicated Installed Application. Client runs as a fully installed software installation that can lockdown desktop space and prevent the ability for the software to be minimized or covered by other applications.
 - c. Windows Desktop App. An app that is downloaded to the client from the server PC, that runs like an installed application, and is automatically updated whenever new apps are available at the server.

E. Primary Network - Panel to Panel Communication:

1. All Building Controllers shall directly reside on the primary BACnet/IP Ethernet network such that communications may be executed directly between Building Controllers, directly between server and Building Controllers on a peer-to-peer basis.

2. Systems that operate via polled response or other types of protocols that rely on a central processor, file server, or similar device to manage panel-to-panel or device-to-device communications shall not be acceptable.
3. All operator interfaces shall have the ability to access all point status and application report data or execute control functions for any and all other devices. Access to data shall be based upon logical identification of building equipment. No hardware or software limits shall be imposed on the number of devices with global access to the network data.
4. The primary network shall use BACnet/IP over Ethernet. All devices must:
 - a. Auto-sense 10/100 Mbps networks.
 - b. Receive an IP Address from a Dynamic Host Configuration Protocol (DHCP) Server or be configured with a Fixed IP Address.
 - c. Resolve Name to IP Addresses for devices using a Domain Name Service (DNS) Server on the Ethernet network.
 - d. Allow MMI access to an individual Primary Network Controller using industry standard Telnet software to view and edit entire Primary Network.
5. The primary network shall provide the following minimum performance:
 - a. Provide high-speed data transfer rates for alarm reporting, report generation from multiple controllers and upload/download efficiency between network devices. System performance shall insure that an alarm occurring at any Building Controller is displayed at any PC workstations, all Building Controllers, and other alarm printers within 15 seconds.
 - b. Message and alarm buffering to prevent information from being lost.
 - c. Error detection, correction, and re-transmission to guarantee data integrity.
 - d. Synchronization of real-time clocks between Building Controllers, including automatic daylight savings time corrections.
 - e. The primary network shall allow the Building Controllers to access any data from, or send control commands and alarm reports directly to, any other Building Controller or combination of

controllers on the network without dependence upon a central or intermediate processing device. Building Controllers shall send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device. The network shall also allow any Building Controller to access, edit, modify, add, delete, back up, restore all system point database and all programs.

- f. The primary network controllers shall back up and restore their own current database including programs, and points without the requirement for connection to a mass storage device.
- g. The primary network controllers shall provide system-wide wild card point search, command, and access direct from any building controller on the network.
- h. The primary network shall allow the Building Controllers to access on-demand display and reports regarding system-wide information including point names, point status, present value, command priority array, trend information, field panel configuration information.
- i. The primary network shall allow the Building Controllers to be configured system-wide by software based tools, and by direct access from any Building Controller on the network. Proprietary vendor specific software shall not be required for system configuration.
- j. The primary network shall allow the Building Controllers to assign password access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the PC workstation or portable terminal. (e.g., all base building and all tenant points shall be accessible to any base building operators, but only certain base building and tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.
- k. Devices containing custom programming may reside on the Primary Network.

F. Secondary Network – Application Specific Controller Communication:

1. Communication over the secondary network shall be BACnet MS/TP protocol.
2. This level communication shall support a family of application specific controllers for terminal equipment.
3. The Application Specific Controllers shall communicate bi-directionally with the primary network through Building Controllers for transmission of global data.
4. A maximum of 60 terminal equipment controllers may be configured on individual secondary networks to ensure adequate global data and alarm response times.

G. Remote Notification: (RENO)

1. Workstations shall be configured to send out messages to numeric pagers, alphanumeric pagers, SMS (Simple Messaging Service, text messaging) Devices, and email accounts based on a point's alarm condition.
2. There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices which can receive messages from the system.
3. On a per point basis, system shall be configurable to send messages to an individual or group and shall be configurable to send different messages to different remote devices based on alarm message priority level.
4. System must be configurable to send messages to an escalation list so that if the first device does not respond, the message is sent on to a second device after a configurable time has elapsed.
5. Workstation shall have the ability to send manual messages allowing an operator to type in a message to be sent immediately.

2.03 Operator Interface:

A. Workstation hardware: (existing)

B. Operator Interface Software:

1. Basic Interface Description

- a. All operator interface functions must be available in clients running in a browser, installed client console, or Windows desktop app.

- b. Operator interface software shall minimize operator training through the use of user-friendly and interactive graphical applications, 256-character English language point identification, on-line help, and industry standard Windows application software. Interface software shall simultaneously communicate with and share data between Ethernet-connected building level networks.
- c. The user interface shall display relevant information for a selection in multiple panes of a single window without the need for opening multiple overlapping windows on the desktop
- d. Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation.
- e. The navigation shall be user friendly by utilizing "forward & back" capability between screens and embedded links to graphics, documents, drawings, trends, schedules, as well as external documents (.doc, .pdf, .xls, etc.) or web addresses that are related to any selected object.
- f. Primary selection of objects in the operator interface software shall be available from user defined hierarchical Views, from graphics, or from events in an Event List.
- g. Secondary selection of objects in the operator interface software shall be available from links to any objects or external documents related to the primary selection. Links to related items shall be automatically defined based on where an object is used in the system.
- h. The operator workstation shall be capable of displaying web pages and common document formats (.doc, .xls, .pdf) within the operator workstation application.
- i. The Operator Workstation Software shall be capable of BACnet IP communications. The BACnet Advanced Workstation (B-AWS) shall have demonstrated interoperability during at least one BTL Interoperability Workshop, have demonstrated compliance to BTL B-AWS device classification through BTL listing as specified in ANSI/ASHRAE 135.

- j. Control product shall support the following BACnet Interoperability Building Blocks to facilitate an open and interoperable system:

BIBB	Name	Initiate	Execute
Data Sharing			
DS-RP-A	Data Sharing-ReadProperty-A	●	
DS-RP-B	Data Sharing-ReadProperty-B		●
DS-RPM-A	Data Sharing-ReadPropertyMultiple-A	●	
DS-RPM-B	Data Sharing-ReadPropertyMultiple-B		●
DS-WP-A	Data Sharing-WriteProperty-A	●	
DS-WP-B	Data Sharing-WriteProperty-B		●
DS-WPM-A	Data Sharing-WritePropertyMultiple-A	●	
DS-COV-A	Data Sharing-COV-A	●	
DS-V-A	Data Sharing-View-A	●	
DS-M-A	Data Sharing-Modify-A	●	
DS-AV-A	Data Sharing-Advanced View-A	●	
DS-AV-A	Data Sharing-Advanced Modify-A	●	
Scheduling			
SCHED-VM-A	Scheduling-View and Modify-A	●	
SCHED-AVM-A	Scheduling-Advanced View and Modify-A	●	
SCHED-WS-A	Scheduling-Weekly Schedule-A	●	
Alarm and Event Management			
AE-N-A	Alarm and Event-Notification-A	●	
AE-ACK-A	Alarm and Event-ACK-A	●	
AE-ASUM-A	Alarm and Event-Alarm Summary-A	●	
AE-ESUM-A	Alarm and Event-Enrolment Summary-A	●	
AE-INFO-A	Alarm and Event-Information-A	●	
AE-AS-A	Alarm and Event-Alarm Summary View-A	●	
AE-VM-A	Alarm and Event-View and Modify-A	●	
AE-AVM-A	Alarm and Event-Advanced View and Modify-A	●	
AE-VN-A	Alarm and Event-View Notifications-A	●	
AE-AVN-A	Alarm and Event-Advanced View Notifications-A	●	
Trending			

BIBB	Name	Initiate	Execute
T-AVM-A	Trending-Advanced View and Modify-A	●	
T-ATR-A	Trending-Automated Trend Retrieval-A	●	
T-V-A	Trending-Trend-View-A	●	
Device and Network Management			
DM-DDB-A	Device Management-Dynamic Device Binding-A	●	
DM-DDB-B	Device Management-Dynamic Device Binding-B		●
DM-DOB-A	Device Management-Dynamic Object Binding-A	●	
DM-DOB-B	Device Management-Dynamic Object Binding-B		●
DM-DCC-A	Device Management-DeviceCommunicationControl-A	●	
DM-TS-A	Device Management-TimeSynchronization-A	●	
DM-UTC-A	Device Management-UTCTimeSynchronization-A	●	
DM-RD-A	Device Management-ReinitializeDevice-A	●	
DM-BR-A	Device Management-Backup and Restore-A	●	
DM-LM-A	Device Management-List Manipulation-A	●	
DM-LM-B	Device Management-List Manipulation-B		●
DM-OCD-A	Device Management-Object Creation and Deletion-A	●	
DM-ANM-A	Automatic Network Mapping-A	●	
DM-ADM-A	Automatic Device Mapping-A	●	
DM-ATS-A	Automatic Time Synchronization-A	●	
DM-MTS-A	Manual Time Synchronization-A	●	

1) BACnet Life Safety Points and BACnet Life Safety Zones

- k. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BMS software clients shall run on a Windows XP, Windows 7 or comparable 32/64-bit operating system. System database parameters shall be stored within an object-oriented database. Standard Windows applications shall run simultaneously with the BMS software. The mouse or Alt-Tab keys shall be used to quickly

select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BMS alarms and monitoring information.

1. The software shall provide, as a minimum, the following functionality:
 - 1) Real-time graphical viewing and control of the BMS environment.
 - 2) Reporting of both real-time and historical information.
 - 3) Scheduling and override of building operations.
 - 4) Collection and analysis of historical data.
 - 5) Point database editing, storage and downloading of controller databases.
 - 6) Configuration of and navigation through default and personalized hierarchical “tree” views that include workstation and control system objects.
 - 7) Event reporting, routing, messaging, and acknowledgment.
 - 8) Definition and construction of dynamic color graphic displays.
 - 9) Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
 - 10) On-screen access to User Documentation, via online help or PDF-format electronic file.
 - 11) Automatic database backup at the operator interface for database changes initiated at Building Controllers.
 - 12) Display dynamic trend data graphical plot.
 - a) Must be able to run multiple plots simultaneously.
 - b) Each plot must be capable of supporting 10 pts/plot minimum.

- c) Must be able to command points from selection on dynamic trend plots.
 - d) Must be able to plot real-time data without prior configuration.
 - e) Must be able to plot both real-time and historical trend data simultaneously.
 - 13) Program editing.
 - 14) Transfer trend data to third-party spreadsheet software
 - 15) Scheduling reports
 - 16) Operator Activity Log
- m. Security
- 1) Operator-specific password access protection shall be provided to allow the administrator/manager to limit users' workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password.
 - 2) Operator privileges shall "follow" the operator to any workstation logged onto.
 - 3) The administrator or manager shall be able to further limit operator privileges based on which console an operator is logged on to.
 - 4) The administrator or manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BMS workstation application.
- n. The operator interface software shall include reports to track the actions of each individual operator. The application shall allow querying based on object name, operator, action, or time range.
- o. Dynamic Color Graphics application shall include the following:
- 1) Must include graphic editing and modifying capabilities.

- 2) All necessary tools and procedures for the user to create their own graphics
 - 3) A library of standard control application graphics and symbols must be included.
 - 4) Must be able to command points directly off graphics application.
 - 5) Graphic display shall include the ability to depict real-time point values dynamically with text or animation.
 - 6) Navigation through various graphic screens shall be optionally achieved through a hierarchical “tree” structure.
 - 7) Graphics viewing shall include dynamic pan zoom capabilities.
 - 8) Graphics viewing shall include the ability to switch between multiple layers with different information on each layer.
 - 9) Graphics shall include a decluttering capability that allows layers to be programmatically hidden and displayed based on zoom level.
 - 10) Graphics shall be capable of displaying the status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
 - 11) Ability to create dashboard views that graphically display system and/ or energy performance. Dashboards will consist of gauges and charts.
- p. Reports shall be generated on demand or via pre-defined schedule. As a minimum, the system shall allow the user to easily obtain the following types of reports:
- 1) A general listing of all or selected points in the network
 - 2) List of all points currently in alarm
 - 3) List of all points currently in override status

- 4) List of all disabled points
 - 5) System diagnostic reports including, list of Building panels on line and communicating, status of all Building terminal unit device points
 - 6) List of alarm strategy definitions
 - 7) List of Building Control panels
 - 8) Point totalization report
 - 9) Point Trend data listings
 - 10) Initial Values report
 - 11) User activity report
 - 12) Event history reports
- q. Scheduling and override
- 1) Provide a calendar type format for simplification of time and date scheduling and overrides of building operations. Schedule definitions reside in the PC workstation and in the Building Controller to ensure time equipment scheduling when PC is off-line, PC is not required to execute time scheduling. Provide override access through menu selection, graphical mouse action or function key. Provide the following capabilities as a minimum:
 - a) Fully support all BACnet Schedule, Calendar, and Command objects.
 - b) Daily and Weekly schedules
 - c) Ability to combine multiple points into a logical Command Groups for ease of scheduling (e.g., Building 1 lights)
 - d) Schedule predefined reports.
 - e) Ability to schedule for a minimum of up to ten (10) years in advance.
 - 2) Additionally, the scheduling application shall:

- a) Provide filtering capabilities of schedules, based on name, time, frequency, and schedule.
 - b) Provide sorting capabilities of schedules, based on name, time and type of schedule.
- r. Collection and Analysis of Historical Data
- 1) Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data shall be collected and stored on hard disk for future diagnostics and reporting. Automatic Trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of equipment. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
 - 2) System shall support trending in the same device as the monitor point or in an external device.
 - 3) Panels shall have a trending level above which the data will be automatically uploaded to the BMS server to prevent overwriting the data in the field panel. The trending level will be user defined in % of available space (e.g., automatically upload when the trend buffer is at 75% of allocated space).
 - 4) Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of selected points.
 - 5) Provide additional functionality that allows the user to view real-time trend data on trend graphical plot displays. A minimum of ten points may be plotted, of either real-time or historical data. The dynamic graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the display and take "snapshots" of plot screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of ten (10) dynamic

graphs shall run simultaneously. Operator shall be able to command points by selecting them on the trend plot. Operator shall be able to zoom in on a specific time range within a plot.

s. Dynamic Color Graphic Displays

- 1) Capability to create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including, but not limited to, air handling units, chilled water systems, hot water boiler systems, and room level terminal units.
- 2) The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, point alarm association, or. Graphics software shall permit the importing of AutoCAD or scanned pictures for use in the system.
- 3) Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations within the system schematics or graphic floor plan displays, and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.
 - a) Provide the user the ability to display real-time point values by animated motion or custom picture control visual representation. Animation shall depict movement of mechanical equipment, or air or fluid flow. Provide users the ability to depict various positions in relation to assigned point values or ranges. A library (set) of animated symbols shall be included within the operator interface software's graphics application. Animation shall reflect, ON or OFF conditions, and shall also be optionally configurable for animation speed.
 - b) Ability to add custom gauges and charts to graphic pages.
 - c) Equipment state or values can be changed by clicking on the associated point block or graphic symbol and selecting the new state (on/off) or setpoint.

- d) State text for digital points can be user-defined.
 - 4) Colors or other visual changes shall be available to indicate status and change as the status of the equipment changes. The state colors shall be user definable.
 - 5) The Windows environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
 - 6) All required software shall be provided to allow the user to add, modify or delete system graphic background displays.
 - 7) A clipart library of HVAC application and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams and laboratory symbols. The user shall have the ability to add custom symbols to the clipart library. The clipart library shall include a minimum of 400 application symbols. In addition, a library consisting of a minimum of at least 100 graphic background templates shall be provided.
 - 8) The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.
 - 9) The Graphics application shall be capable of automatically assigning the appropriate symbol for an object (point) selected to be displayed on the graphic based on what the object represents (fan, duct sensor, damper, etc.)
- t. System Configuration & Definition
- 1) The system shall be fully configurable from clients running in a browser, installed client console, or Windows desktop app.
 - 2) Users must be able to build multiple, separate, personalized hierarchical "tree" views that represent the workstation,

control systems, geographical facility layouts, and mechanical equipment relationships.

- 3) Network wide control strategies shall not be restricted to a single Building Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.
- 4) Provide automatic backup and restore of all Building Controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate Building Controller. Changes made at the user-interface of Building Controllers shall be automatically uploaded to the workstation, ensuring system continuity.
- 5) System configuration, programming, editing, graphics generation shall be performed on-line from the operator workstation software.
- 6) User shall be able to edit point configuration online within a dedicated editor application. The editor shall allow the user to create, view existing, modify, copy, and delete points from the database.
- 7) User shall be able to edit point configuration of any configurable BACnet point that resides in a devices that supports external editing.
- 8) The software shall also allow the user to configure the alarm management strategy for each point. The editor shall provide the ability for editing the point database directly online with the Building Controllers.
- 9) The operator interface software shall also provide the capability to perform bulk modification of point definition attributes to a single or multiple user-selected points.
- 10) Control program configuration shall be available to the user within a dedicated control program editor application. The editor shall allow for creation, modification and deletion of control programs. The editor shall also include the ability to automatically compile the program to ensure its compatibility with the Building Controllers. The editor

shall provide the ability to selectively enable or disable the live program execution within the Building Controllers.

- 11) Users shall have the ability to view the program(s) that is\are currently running in a Building Controller. The display shall mark the program lines with the following: disabled, comment, unresolved, and trace bits.

u. Event Management

- 1) Event Routing shall allow the user to send event notification to selected printers or workstation location(s) based on event severity, or point type.
- 2) Event Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each event: name, value, event time and date, event status, priority, acknowledgement information, and alarm count. Each event shall have the ability to sound an audible notification based on the category of the event.
- 3) Event List shall have the ability to list and sort the events based on event status, point name, ascending or descending activation time.
- 4) Directly from the Event List, the user shall have the ability to acknowledge, silence the event sound, print, or erase each event. The interface shall also have the option to inhibit the erasing of active acknowledged events, until they have returned to normal status. The user shall also have the ability to navigate to all information related to a selected point in order to command, launch an associated graphic or trended graphical plot, or run a report on a selected point directly from the Event List.
- 5) Each event shall have a direct link from the Event List to further user-defined point informational data. The user shall have the ability to also associate real-time electronic annotations or notes to each event.

2.04 Building Controller Software

A. General:

1. Furnish the following applications software to form a complete operating system for building and energy management as described in this specification.
2. The software programs specified in this section shall be provided as an integral part of Building Controllers and shall not be dependent upon any higher level computer or another controller for execution.
3. All points, panels and programs shall be identified by a 30-character name. All points shall also be identified by a 16-character point descriptor. The same names shall be displayed at both Building Controller and the Operator Interface.
4. All digital points shall have a user defined two-state status indication with 8 characters minimum (e.g., Summer, Enabled, Disabled, Abnormal).
5. The Building Controller Software shall be capable of BACnet communications. The BACnet Building Controller (B-BC) shall have demonstrated interoperability during at least one BTL Interoperability Workshop, have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Building Controller (B-BC) device profile as specified in ANSI/ASHRAE 135-2004 or ANSI/ASHRAE 135-2008.
6. Control product shall support the following BACnet Interoperability Building Blocks to facilitate an open and interoperable system:

BIBB	Name	Initiate	Execute
Data Sharing			
DS-RP-A	Data Sharing-ReadProperty-A	<input type="checkbox"/>	
DS-RP-B	Data Sharing-ReadProperty-B		<input type="checkbox"/>
DS-RPM-A	Data Sharing-ReadPropertyMultiple-A	<input type="checkbox"/>	
DS-RPM-B	Data Sharing-ReadPropertyMultiple-B		<input type="checkbox"/>
DS-WP-A	Data Sharing-WriteProperty-A	<input type="checkbox"/>	
DS-WP-B	Data Sharing-WriteProperty-B		<input type="checkbox"/>
DS-WPM-B	Data Sharing-WritePropertyMultiple-B		<input type="checkbox"/>
DS-COV-A	Data Sharing-COV-A	<input type="checkbox"/>	
DS-COV-B	Data Sharing-COV-B		<input type="checkbox"/>
DS-COVU-A	Data Sharing-COV-Unsolicited-A	<input type="checkbox"/>	
DS-COVU-B	Data Sharing-COV-Unsolicited-B		<input type="checkbox"/>

BIBB	Name	Initiate	Execute
Scheduling			
SCHE-I-B	Scheduling-Internal-B		<input type="checkbox"/>
SCHE-E-B	Scheduling-External-B		<input type="checkbox"/>
Alarm and Event Management			
AE-N-A	Alarm and Event-Notification-A	<input type="checkbox"/>	
AE-N-I-B	Alarm and Event-Notification Internal-B		<input type="checkbox"/>
AE-N-E-B	Alarm and Event-Notification External-B		<input type="checkbox"/>
AE-ACK-A	Alarm and Event-ACK-A	<input type="checkbox"/>	
AE-ACK-B	Alarm and Event- ACK-B		<input type="checkbox"/>
AE-ASUM-B	Alarm and Event-Alarm Summary-B		<input type="checkbox"/>
AE-ESUM-A	Alarm and Event-Enrollment Summary-A	<input type="checkbox"/>	
AE-ESUM-B	Alarm and Event-Enrollment Summary-B		<input type="checkbox"/>
AE-INFO-A	Alarm and Event-Information-A	<input type="checkbox"/>	
AE-INFO-B	Alarm and Event-Information-B		<input type="checkbox"/>
Trending			
T-VMT-A	Trending-Viewing and Modifying Trends-A	<input type="checkbox"/>	
T-VMT-I-B	Trending-Viewing and Modifying Trends-Internal-B		<input type="checkbox"/>
T-VMT-E-B	Trending-Viewing and Modifying Trends-External-B		<input type="checkbox"/>
T-ATR-B	Trending-Automated Trend Retrieval-B		<input type="checkbox"/>
Network Management			
NM-CE-A	Network Management-Connection Establishment-A	<input type="checkbox"/>	
Device Management			
DM-DDB-A	Device Management-Dynamic Device Binding-A	<input type="checkbox"/>	
DM-DDB-B	Device Management-Dynamic Device Binding-B		<input type="checkbox"/>
DM-DOB-A	Device Management-Dynamic Object Binding-A	<input type="checkbox"/>	

BIBB	Name	Initiate	Execute
DM-DOB-B	Device Management-Dynamic Object Binding-B		<input type="checkbox"/>
DM-DCC-B	Device Management-DeviceCommunicationControl-B		<input type="checkbox"/>
DM-PT-A	Device Management-Private Transfer-A	<input type="checkbox"/>	
DM-PT-B	Device Management-Private Transfer-B		<input type="checkbox"/>
DM-TM-A	Device Management-Text Message-A	<input type="checkbox"/>	
DM-TM-B	Device Management-Text Message-B		<input type="checkbox"/>
DM-TS-B	Device Management-TimeSynchronization-B		<input type="checkbox"/>
DM-RD-B	Device Management-ReinitializeDevice-B		<input type="checkbox"/>
DM-BR-B	Device Management-Backup and Restore-B		<input type="checkbox"/>
DM-LM-B	Device Management-List Manipulation-B		<input type="checkbox"/>
DM-OCD-B	Device Management-Object Creation and Deletion-B		<input type="checkbox"/>

7. Building Controllers shall have the ability to perform energy management routines including but not limited to time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating/cooling interlock, supply temperature reset, priority load shedding, and power failure restart.
8. The Building Controllers shall have the ability to perform the following pre tested control algorithms:
 - a. Two position control
 - b. Proportional control
 - c. Proportional plus integral control
 - d. Proportional, integral, plus derivative control
 - e. Automatic tuning of control loops
 - f. Model-free adaptive control
9. Each controller shall be provided with an interactive HELP function to assist operators using POTs and remote connected operators.

10. Building Controllers shall not be susceptible to Microsoft Windows operating systems based viruses.

B. System Security

1. User access shall be secured using individual security passwords and user names.
2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
3. User Log On/Log Off attempts shall be recorded.
4. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
5. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the field panel.

C. User Defined Control Applications:

1. Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
2. It shall be possible to use any system measured point data or status, any system calculated data, a result from any process, or any user-defined constant in any controller in the system.
3. Any process shall be able to issue commands to points in any and all other controllers in the system.
4. Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
5. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.

6. Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task oriented information from the user manual.

D. Alarm Management:

1. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each Building Controller shall perform distributed, independent alarm analysis, minimize network traffic and prevent alarms from being lost. At no time shall the Building Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
2. Conditional alarming shall allow generation of alarms based upon user defined multiple criteria.
3. An Alarm “shelving” feature shall be provided to disable alarms during testing. (Pull the Plug, etc.).
4. Binary Alarms. Each binary object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
5. Analog Alarms. Each analog object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
6. All alarm or point change reports shall include the point's user-defined language description and the time and date of occurrence.
7. Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages, and display graphics.
8. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200-character alarm message to more fully describe the alarm condition or direct operator response.
9. Each Building Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assigned to any number of points in the Controller.
10. Operator-selected alarms shall be capable of initiating a call to a remote operator device.

E. Scheduling:

1. Provide a comprehensive menu driven program to automatically start and stop designated multiple objects or events in the system according to a stored time.
 2. Schedules shall reside in the building controller and shall not rely on external processing or network.
 3. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start and/or stop within that group.
 4. The operator shall be able to define the following information:
 - a. Time, day
 - b. Commands such as on, off, auto, etc.
 - c. Time delays between successive commands.
 - d. There shall be provisions for manual overriding of each schedule by an authorized operator.
 5. It shall be possible to schedule calendar-based events up to one year in advance based on the following:
 - a. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, and stop.
 - b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.
- F. Automatic Daylight Savings Time Switchover. The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
- G. Night setback control. The system shall provide the ability to automatically adjust setpoints for night control.
- H. Enthalpy switchover (economizer). The Building Controller Software (BCS) shall control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover setpoint the BCS will

modulate the dampers to provide 100 percent outside air. The user will be able to quickly change over to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.

- I. Loop Control. A Model-Free Adaptive Control algorithm or alternatively a PID (proportional-integral-derivative) closed-loop control algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and weighting parameters shall be user-selectable.
- J. Sequencing. Provide application software based upon the sequences of operation specified to properly sequence equipment.
- K. Staggered Start:
 - 1. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable.
 - 2. Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.
- L. Totalization:
 - 1. Run-Time Totalization. Building Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.
 - 2. Consumption totalization. Building Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.
 - 3. Event totalization. Building Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.
- M. Data Collection:

1. A variety of historical data collection utilities shall be provided to manually or automatically sample, store, and display system data for all points.
2. Building Controllers shall store point history data for selected analog and digital inputs and outputs:
 - a. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each Building Controllers point group.
3. Trend data shall be stored at the Building Controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in third-party personal computer applications.
4. Loop Tuning. Building Controllers shall also provide high resolution sampling capability for verification of DDC control loop performance. Documented evidence of tuned control loop performance shall be provided on a <monthly, seasonal, quarterly, annual> period.
 - a. For Model-Free Adaptive Control loops, evidence of tuned control loop performance shall be provided via graphical plots or trended data logs. Graphical plots shall minimally include depictions of setpoint, process variable (output), and control variable (e.g., temperature). Other parameters that may influence loop control shall also be included in the plot (e.g., fan on/off, mixed-air temp).
 - b. For PID control loops, operator-initiated automatic and manual loop tuning algorithms shall be provided for all operator-selected PID control loops. Evidence of tuned control loop performance shall be provided via graphical plots or trended data logs for all loops.
 - 1) In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.
 - 2) Loop tuning shall be capable of being initiated either locally at the Building Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

2.05 Building Controllers (BC)

- A. Building Controllers shall be 32-bit, multi-tasking, multi-user, real-time 100 MHz digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
- B. Each Building Controller shall have sufficient memory, a minimum of 24 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, and dial-up communications.
- C. Provide Universal I/O capability, including software configurable universal inputs and universal outputs.
- D. Shall support a minimum of one directly connected Secondary Network.
- E. Building Controller shall have an integral real-time clock.
- F. Each Building Controller shall support firmware upgrades without the need to change hardware.
- G. Each Building Controller shall support:
 - 1. Monitoring of industry standard analog and digital inputs, without the addition of equipment outside the Building Controller cabinet.
 - 2. Monitoring of industry standard analog and digital outputs, without the addition of equipment outside the Building Controller cabinet.
- H. Spare Point Capacity. Each Building Controller shall have a minimum of 10 percent spare point capacity.
 - 1. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than one spare of each implemented I/O type.
 - 2. Provide all processors, power supplies, and communication controllers so that the implementation of adding a point to the spare point location only requires the addition of the appropriate:
 - a. Expansion modules

- b. Sensor/actuator
 - c. Field wiring/tubing
- I. Serial Communication. Building Controllers shall provide at least one EIA-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals. Building Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals. A USB port shall alternatively be available to support local HMI tools connection.
- J. Printer support. A USB port shall be available to support printers for printed alarm record keeping.
- K. I/O Status and Indication. Building Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. All wiring connections shall be made to field-removable terminals.
- L. Shall provide I/O modules with LCD's capable of displaying information faults including but not limited to open circuit, short circuit, unreliable input signal, signal under range, and signal over range via informative symbols.
- M. Self Diagnostics. Each Building Controller shall continuously perform self diagnostics, communication diagnosis, and diagnosis of all panel components. The Building Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication for any system.
- N. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.
- O. Environment.
 - 1. Controller hardware shall be suitable for the anticipated ambient conditions.

2. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
 3. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
- P. Immunity to power and noise.
1. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
 2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
 3. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 - a. RF-Conducted Immunity (RF-CI) per ENV 50141 (IEC 1000-4-6) at 3V.
 - b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
 - c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.
 - d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
 4. Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:
 - a. IEEE Standard 587 1980
 - b. UL 864 Supply Line Transients
 - c. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

2.06 Advanced Application Controller Software

A. General:

1. Furnish the following applications software to form a complete operating system for building and energy management as described in this specification.
2. The software programs specified in this section shall be provided as an integral part of Advanced Application Controllers and shall not be dependent upon any higher level computer or another controller for execution.
3. The Advanced Application Controller Software shall be capable of BACnet communications. The BACnet Advanced Application Controller (B-AAC) shall have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Advanced Application Controller (B-AAC) device profile as specified in ANSI/ASHRAE 135-2004 or ANSI/ASHRAE 135-2008.
4. Control product shall support the following BACnet Interoperability Building Blocks to facilitate an open and interoperable system:
5. Advanced Application Controllers shall have the ability to perform energy management routines including but not limited to scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating/cooling interlock, supply temperature reset, priority load shedding, and power failure restart.
6. The Advanced Application Controllers shall have the ability to perform the following pre tested control algorithms:
 - a. Two position control
 - b. Proportional control
 - c. Proportional plus integral control
 - d. Proportional, integral, plus derivative control
 - e. Automatic tuning of control loops
 - f. Model-free adaptive control

B. System Security

1. User access shall be secured using individual security passwords and user names.
2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
3. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
4. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the field panel.

C. User Defined Control Applications:

1. Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
2. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.
3. Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task oriented information from the user manual.

2.07 Advanced Application Controllers (AAC)

- D. Advanced Application Controllers shall be 32-bit, multi-tasking, real-time 100 MHz digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point list.
- E. Each Advanced Application Controller shall have sufficient memory, a minimum of 24 megabyte, to support its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, and operator I/O.
- F. Provide Universal I/O capability, including software configurable universal inputs and universal outputs

- G. Advanced Application Controller shall have an integral real-time clock.
- H. Each Advanced Application Controller shall support firmware upgrades without the need to change hardware.
- I. Each Advanced Application Controller shall support:
 - 1. Monitoring of industry standard analog and digital inputs, without the addition of equipment outside the controller cabinet.
 - 2. Monitoring of industry standard analog and digital outputs, without the addition of equipment outside the controller cabinet.
- J. Spare Point Capacity. Each Advanced Application Controller shall have a minimum of 10 percent spare point capacity.
 - 1. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than one spare of each implemented I/O type.
 - 2. Provide all processors, power supplies, so that the implementation of adding a point to the spare point location only requires the addition of the appropriate:
 - a. Sensor/actuator
 - b. Field wiring/tubing
- K. Serial Communication. Advanced Application Controllers shall provide at least one EIA-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals. Advanced Application Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals. A USB port shall alternatively be available to support local HMI tools connection.
- L. Printer support. A USB port shall be available to support printers for printed alarm record keeping.
- M. I/O Status and Indication. Advanced Application Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output.
- N. Self Diagnostics. Each Advanced Application Controller shall continuously perform self diagnostics, communication diagnosis, and diagnosis of all panel

components. The controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication for any system.

- O. Power loss. In the event of the loss of power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.
- P. Environment.
 - 1. Controller hardware shall be suitable for the anticipated ambient conditions.
 - 2. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
 - 3. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 0°C to 49°C (32°F to 120°F).
- Q. Immunity to power and noise.
 - 1. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
 - 2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
 - 3. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 - a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V.
 - b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
 - c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.
 - d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).

4. Isolation shall be provided at all Advanced Application Controller's AC input terminals to suppress induced voltage transients consistent with:
 - a. IEEE Standard 587 1980
 - b. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

R. Minimum Approved Advanced Application Controllers. BMS Contractors shall furnish Advanced Application Controllers as listed below. Providing an approved controller does not release the contractor from meeting all performance, software and hardware specifications for Building Controllers and system operations.

1. Siemens Industry, Inc. – PXC Compact Unitary Equipment Controllers.
2. [User Definable]

2.08 Application Specific Controllers (ASC)

A. General:

1. Provide for control of each piece of equipment , including, but not limited to the following:
 - a. Variable Air Volume (VAV) boxes
 - b. Reheat Coils (RH)
 - c. Fan Coil Units (FCU)
 - d. Fan Powered Boxes (FPB)
 - e. Unit Conditioners
 - f. Heat Pumps
 - g. Unit Ventilators
 - h. Demand Control Ventilation (DCV)
 - i. Chilled Beam
 - j. Room Pressurization

2. Each Building Controller shall be able to communicate with application specific controllers (ASCs) over the Secondary Network to control terminal equipment only.
3. The use of Secondary Network controllers with custom program applications to control AHU's, water systems, etc. is not acceptable.
4. Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall provide standard applications and programmability to provide both reliability and flexibility. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.
5. The Application Specific Controller Software shall be capable of BACnet communications. The BACnet Application Specific Controller (B-ASC) shall have demonstrated interoperability during at least one BTL Interoperability Workshop, have demonstrated compliance to BTL through BTL listing and shall substantially conform to BACnet Application Specific Controller (B-ASC) device profile as specified in ANSI/ASHRAE 135-2004.
6. Control product shall support the following BACnet Interoperability Building Blocks to facilitate an open and interoperable system:
7. Each ASC shall include all point inputs and outputs necessary to perform the specified control sequences. The ASC shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control output signals shall not be acceptable. Outputs utilized either for two-state, modulating floating, or proportional control, allowing for additional system flexibility.
8. Space Temperature Sensors. Each controller performing space temperature control shall be provided with a matching room temperature sensor.
 - 1) Digitally communicating with the Application Specific Controller.
 - 2) Mountable to and fully covering a 2 x 4 electrical junction box without the need for an adapter wall plate.
 - 3) IC Element Accuracy: +/- 0.9°F
 - 4) Operating Range: 55 to 95°F

- 5) Setpoint Adjustment Range: User limiting, selectable range between 55 and 95°F
 - 6) Calibration: Single point, field adjustable at the space sensor to +/- 5°F
 - 7) Installation: Up to 100 ft. from controller
 - 8) Auxiliary Communications Port: included
 - 9) Local OLED Temperature Display: included
 - 10) Display of Temperature to one decimal place
 - 11) Temperature Setpoint Adjustment included
 - 12) Occupancy Override Function included
- b. Auxiliary Communication Port. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. RS-232 communications port shall allow the operator to query and modify operating parameters of the local room terminal unit from the portable operator's terminal.
- c. Setpoint Adjustment Dial. The setpoint adjustment function shall allow for modification of the temperature by the building operators. Setpoint adjustment may be locked out, overridden, or limited as to time or temperature through software by an authorized operator at any central workstation, Building Controller, room sensor two-line display, or via the portable operator's terminal.
- d. Override Switch. An override button shall initiate override of the night setback mode to normal (day) operation when activated by the occupant and enabled by building operators. The override shall be limited to two (2) hours (adjustable.) The override function may be locked out, overridden, or limited through software by an authorized operator at the operator interface, Building Controller, room sensor two-line display or via the portable operator's terminal.
9. Space Combination Temperature and Humidity Sensors. Each controller performing space temperature control shall be provided with a matching room temperature sensor, which also includes the ability to measure

humidity for either monitoring or control purposes. The combination temperature and humidity sensors shall have the same appearance as the space temperature sensors. Humidity elements shall measure relative humidity with a +/- 2% accuracy over the range of 10 to 90% relative humidity. Humidity element shall be an IC (integrated circuit) sensing element. Humidity sensing elements shall be removable and field replaceable if needed.

10. Space Combination Carbon Dioxide (CO₂)/Temperature or Carbon Dioxide/Temperature/Relative Humidity Sensors. Each controller performing space temperature, relative humidity or CO₂ control shall be provided with a single room sensor, which includes the ability to measure CO₂ and temperature or CO₂, temperature and relative humidity for either monitoring or control purposes. The combination sensors shall have the same appearance as the space temperature sensors. Room sensing devices shall be digitally communicating with the zone controller, and multiple sensed values (CO₂, RH) should not utilize additional analog inputs on the controller. CO₂ elements shall be of the non-dispersive infrared (NDIR) technology type, and shall measure over the range of 0 to 2000 parts per million (PPM), with an accuracy of +/- 50PPM + 2% of reading. Where display is needed, display shall be of the organic light emitting diode (OLED) type. Room sensor shall be capable of showing or hiding any displayed value. Measured values (CO₂, humidity and temperature) shall be capable of being field calibrated at a single point, as a one-point bias/offset calibration, without the use of additional calibration software. Humidity elements shall measure relative humidity with a +/- 2% accuracy over the range of 10 to 90% relative humidity. Humidity element shall be an IC (integrated circuit) sensing element. Humidity sensing elements shall be removable and field replaceable if needed.
11. Communication. Each controller shall perform its primary control function independent of other Secondary Network communication, or if Secondary Network communication is interrupted. Reversion to a fail-safe mode of operation during Secondary Network interruption is not acceptable.
12. Control Algorithms. The controller shall receive its real-time data from the Building Controller time clock to ensure Secondary Network continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via room sensor LCD or the portable operator's terminal as specified herein. Controllers that incorporate proportional and integral (PI) control algorithms only shall not be acceptable.
13. Control Applications. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to

meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.

14. Programmability. Application Specific Controllers shall be programmable, using software provided by the BMS manufacturer. Software shall be field-installable on any standard laptop or Portable Operator's Terminal. Program language shall be text-based and allow up to 200 lines of code for programming. Programming shall allow for changing sequence of operation, commanding and releasing points, additional monitoring, and command priority management within the Application Specific Controller.
15. Calibration. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and ensuring against drift over time.
 - a. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.
 - b. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 cfm air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa.
 - c. Calibration shall be accomplished by zeroing out the pressure sensor and holding damper at last known position until calibration is complete. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa.
16. Memory.
 - a. Provide each ASC with sufficient memory to accommodate point databases, operating programs, programming capability, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM, or minimum of 72-hour battery backup shall be provided. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.
 - b. Upon replacement, new ASCs shall recover control function and site specific defaults automatically and resume normal operation.

17. Power Supply. The ASCs shall be powered from a 24 Vac source and shall function normally under an operating range of 18 to 28 Vac, allowing for power source fluctuations and voltage drops. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type. The BMS contractor shall provide 24 Vac power to the terminal units by utilizing:
 - a. The existing line voltage power trunk and installing separate isolation transformers for each controller.
 - b. Dedicated line voltage power source and isolation transformers at a central location and installing 24 Vac power trunk to supply multiple ASCs in the area.
18. Environment. The controllers shall function normally under ambient conditions of 32 to 122°F (0 to 50°C) and 10% to 95% rh (non-condensing). Provide each controller with a suitable cover or enclosure to protect the circuit board assembly.
19. Immunity to noise. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
20. Manufacturer Installed Controls.
 - a. BMS manufacturer shall furnish ASC and actuator for factory mounting to equipment manufacturer.
 - b. Cost of factory mounting shall be borne by equipment manufacturer.
 - c. For VAV terminals, equipment manufacturer shall provide and install flow-cross sensor, 24 Vac transformer, controls enclosure, fan relay, SCR and factory install, wire and tube ASC controller and actuator.
 - d. Fan powered VAV terminals shall be equipped with a fan speed controller and relay to change summer and winter speed setpoint.

B. Controllers for VAV terminals.

1. All VAV terminal control applications shall be field selectable such that a single controller may be used in conjunction with any of the above types of terminal units to perform the specified sequences of control. . In addition to the field selectable applications, additional programming flexibility to meet sequences of control is required in all ASCs. ASCs that

require factory application changes are not acceptable. The VAV terminal ASC shall support the following types of pressure independent terminal boxes as a minimum:

- a. VAV cooling only
 - b. VAV with hot water or electric reheat
2. VAV applications shall be able to monitor relative space humidity and CO₂.
 3. The controller shall include a differential pressure transducer that shall connect to the terminal unit manufacturer's standard averaging air velocity sensor to measure the average differential pressure in the duct. The controller shall convert this value to actual airflow. Single point air velocity sensing is not acceptable. The differential pressure transducer shall have a measurement range of 0 to 4000 fpm (0 to 20.4 m/s) and measurement accuracy of +5% at 400 to 4000 fpm (2 to 20 m/s), insuring primary airflow conditions shall be controlled and maintained to within +5% of setpoint at the specified parameters. The BMS contractor shall provide the velocity sensor if required to meet the specified functionality.

2.09 Power Supplies and Line Filtering

- A. Control transformers shall be UL listed. Furnish Class 2 current-limiting type or furnish over-current protection in both primary and secondary circuits for Class 2 service in accordance with NEC requirements. Limit connected loads to 80% of rated capacity.
- B. DC power supply output shall match output current and voltage requirements. Unit shall be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation shall be 1.0% line and load combined, with 100-microsecond response time for 50% load changes. Unit shall have built-in over-voltage and over-current protection and shall be able to withstand a 150% current overload for at least three seconds without trip-out or failure.
 1. Unit shall operate between 0°C and 50°C (32°F and 120°F). EM/RF shall meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
 2. Line voltage units shall be UL recognized and CSA approved.
- C. Power line filtering.

1. Provide transient voltage and surge suppression for all workstations and controllers either internally or as an external component. Surge protection shall have the following at a minimum:
 - a. Dielectric strength of 1000 volts minimum,
 - b. Response time of 10 nanoseconds or less,
 - c. Transverse mode noise attenuation of 65 dB or greater,
 - d. Common mode noise attenuation of 150 dB or better at 40 Hz to 100 Hz.

2.10 Auxiliary Control Devices

A. GENERAL

1. Specified in this section are the following hard wired input/output devices connected to the Building Controller or ASC.
 - a. Automatic Dampers
 - b. Fire/Smoke Dampers
 - c. Electric Damper Actuators
 - d. Motorized Isolation Valves
 - e. Ball Valves
 - f. Automatic Control Valves
 - g. Air Velocity Sensors
 - h. Airflow Measuring Stations
 - i. Binary Temperature Devices
 - j. Temperature Sensors
 - k. Dew Point/Humidity Sensors
 - l. Pressure Sensors
 - m. Water Differential Pressure Sensors
 - n. Differential Pressure Switches
 - o. Analog Water Level Sensors
 - p. Water Leak Detection Systems
 - q. Audio/Visual Alarm Units
 - r. Water BTU Meters
 - s. Water Flow Switches
 - t. Indoor Air Quality (CO₂/VOC/TEMP/RH) Space Sensors
 - u. Relays
 - v. Override Timers
 - w. Current Transformers
 - x. Voltage Transmitters
 - y. Voltage Transformers

- z. Power Monitors
- aa. Current Switches
- bb. Local Control Panels

2. Specified in this section are the following devices connected to the BMS using serial communication.

- a. Water BTU Meters
- b. Variable Frequency Drives (VFD)
- c. Indoor Air Quality (CO₂/VOC) Space Sensors
- d. Power Monitors

B. AUTOMATIC DAMPERS

1. Dampers shall have 13 gauge galvanized frames of not less than 3 inches wide and blades of 14 gauge, equivalent thickness, galvanized steel roll formed airfoil type for low pressure drop and low noise generation and shall be adequately braced to from a rigid assembly where required in galvanized duct work. Dampers shall have blades not more than 8 inches wide. Linkage and hardware shall be zinc plated steel and shall be concealed out of airstream within the damper frame. Damper blades and rods shall be installed in horizontal position.
2. In copper, aluminum and stainless steel ductwork, damper material shall match the ductwork material.
3. All dampers shall be of the proportioning or opposed blade type, and shall be motor operated. Dampers shall have continuous elastomer or stainless steel stops to avoid leakage. Bearings shall be corrosion resistant oil tight stainless steel sleeve type. All dampers shall be provided with continuous 3/16" x 1/2" closed cell neoprene gasket around perimeter of the frame and at interlocking blade edges to form an air tight seal. Blade seals shall be suitable for -76°F to 350°F mechanically locked into blade edge. Adhesive of clip on type are not acceptable. Axles shall be square or hexagonal positively locked into damper blade. Linkage shall be concealed out of airstream within the damper blade.
4. All dampers shall be constructed to provide a maximum leakage of 3-1/2%, with an approach velocity of 1500 fpm when closed against a pressure of 4 inches of water. Submit leakage and flow characteristic data for all dampers.
5. All outside air dampers, with the exception of the emergency generator dampers, shall automatically close in the event of a loss of power. Dampers on emergency generators shall automatically open on a loss of power.

6. All smoke dampers shall be constructed in accordance with UL Standard 555S.
7. Dampers shall be Greenheck, Imperial Model 800, Ruskin CD36 or approved equal.

C. FIRE/SMOKE DAMPERS

1. Dampers shown on drawings designated as “F/SM” shall comply with the following. They shall have a U.L. label. Dampers shall be electronically operated combination fire and smoke Greenheck Imperial or approved equal, provided with factory installed U.L. rated full sleeves. Provide air foil or “V” blade damper blades supported with shafts and stainless steel bearings to allow daily operation. Provide intermediate supports and bearings for damper blades more than 36” long. They shall conform to UL Standard 555 and 555S as leakage rated dampers in smoke control systems when closed shall be the equivalent of a 1-1/2 hour fire damper. Leakage shall conform to Class 2 with maximum leakage of 10 cfm/Sq. Ft. at 1” W.G. Damper actuators shall be provided with position indicator switches to enable remote status of open or closed positions (only those dampers designated in the electrical trade plans and specifications will be provided with position switches and will be wired for remote status and remote open/closed operation, but all dampers will be provided with position indicators for possible future use). Note that dampers which are controlled from a central fire command station shall be provided with a 212°F heat sensor with normally closed contacts (manual reset) to close and lock damper if open. Additionally, dampers shall be factory equipped with a second normally closed heat sensor correlating to the operator/actuator degradation temperature classification (250°F to 350°F, depending on the actuator utilized). The second sensor is wired through a manual override switch on the central fire command station. Dampers which are not controlled from a central fire command station shall have a fusible link which melts on heat causing damper to close and lock in a closed position. The following will be accepted in lieu of the two firestats described. A resettable bimetallic link which opens on heat permitting damper to close and lock if open. This link may be re-engaged from fire command station at temperature of 150°F or less.
2. Dampers shown on drawings designated “SM” shall comply in all respects to F/S damper description including position indicating switches except they shall not be provided with a heat sensor or fusible link.

D. Electric Damper Actuators

1. General

- a. All actuators shall be manufactured; brand labeled, or distributed by Siemens.
- b. All damper actuators having more than 100 lb-in torque output shall have a self-centering damper shaft clamp. V-bolt type damper shaft clamp is not acceptable.
- c. The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator throughout the rotation of the actuator.
- d. Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing. Alternatively, an uninterruptible power supply (UPS) may be provided. On terminal unit valves actuators and 2-second timing damper actuators capacitor driven fail action is permitted.
- e. Modulating actuator shall accept a 0-10 Vdc control signal and provide a 0-10 Vdc operating range
- f. All 24 Vac/Vdc actuators shall operate on Class 2 wiring.
- g. All actuators over 20 lb-in torque capacity shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered and spring-return actuators shall have a manual crank for this purpose.
- h. Upon start up and after power loss, the actuator must immediately respond to control signals. Actuators requiring calibration to determine end stops are not acceptable.
- i. Electric actuators for emergency generator damper control shall be rated for 350°F maximum operating temperature and capable to drive fully open and close within 15 seconds.
- j. All actuators that provide a factory mounted electrical appliance or plenum rated cabling must be marked with numbers on the wires as well as color coded.
- k. Provide built-in dual end switches as required for the sequence of operation.
- l. Control damper actuators shall be RoHS Part A compliant.

E. MOTORIZED ISOLATION VALVES

1. Butterfly Valves.

- a. Furnish automatic butterfly valves for isolation requirements as shown on the drawings or required herein. All butterfly valves shall have body ratings in accordance with the piping specifications. Valves shall be high performance, fully lugged with carbon steel body ANSI 150/300. Valves shall be rated for bubble tight dead end closure, with 316 stainless steel disc, stainless steel shaft and reinforced Teflon® seat and seals.
- b. Motorized valves located outdoors or in areas subject to outdoor air conditions provide fail in place, electric operators with water proof enclosure, crankcase heater, and open and closed position limit switches. Valve and all accessories shall be constructed for outdoor use. All electrical devices shall be weather proof and NEMA 4 rated.
- c. All valves shall be provided with external position indicators and a speed control device to prevent to rapid closure.
- d. All valves 8 inch and larger shall be provided with manual override hand wheels for operating the valve.
- e. The valves shall be line size as shown on plans.
- f. Motorized isolation valves shall be Jamesbury 815/830L, Fisher, DeZurik Model HP II, Tyco/Siemens or Bray.

F. BALL VALVES.

1. Furnish automatic full port ball valves for isolation requirements on line sizes up to 2 inches as shown on the drawings or required herein. All ball valves shall have ANSI 250 body rating. Valves shall bronze body and stainless steel trim.
2. Valves shall close against a differential pressure equal to the design pump head pressure plus 10%.
3. The valves shall fail to their safe position upon power loss as specified in the sequence of operation.
4. All valves shall be provided with manual override.

5. Provide valve position indicator end switches with the actuator.
6. The valves shall be line size as shown on plans.
7. Motorized isolation valves shall be Nepronic, Dezurik or Siemens Industry, Inc.

G. AUTOMATIC CONTROL VALVES.

1. General:

- a. Control valves shall be two-way or three-way type single seated globe type for two-position or modulating service as shown. Valves less than 1-1/2" shall meet ANSI Class IV leakage rating.
- b. All valves line size 2" or less shall be pressure independent.
- c. Body pressure rating shall be ANSI Class 250 or better and connection type construction shall conform to pipe, fitting and valve schedules
- d. Valve actuators shall be of electric type.
- e. Control valve operators shall be sized to close against a differential pressure equal to the design pump head in normal operation.
- f. Provide valves 2 inches and smaller with screwed end bronze or brass bodies. Provide valves 2-1/2 inches and larger with flanged ends, cast iron body and stainless steel trim.
- g. For modulating service that require large valve size (above 6 inches), such as cooling tower temperature bypass, chiller head pressure ,etc. where proper control with globe type control valve cannot be achieved or the application is not economical butterfly valves are allowed.

2. Water Valves:

- a. Control valves shall provide reliable flow characteristics for modulating service.
- b. Sizing Criteria (non-Pressure Independent):
 - 1) Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through the coil, 50% of the

pressure difference between supply and return mains, or 5 psi, whichever is greater.

- 2) Water valves shall fail normally open or closed, as scheduled on plans, or as required by sequences of operation.

c. Sizing Criteria (Pressure Independent):

- 1) Two-way modulating service: Two-way modulating service: Maximum flow shall be limited to the design flow of the coil. This GPM will be used to size the valve, not the traditional flow coefficient and pressure drop method.
- 2) The differential pressure range for effective pressure independent operation shall be 2.6 – 58 psi for ½” valves, in no instance shall the minimum effective pressure differential for effective pressure independent operation exceed 4 psi for valves under 2” line size.

d. Pressure Independent control Valves (PICV) - where specifically required as shown on mechanical plans only.

- 1) Valves shall be of globe-style bodies.
- 2) Valves shall contain a pressure independent regulator, a variable flow control, and an adjustable flow limiter.
- 3) The adjustable flow limiter shall indicate maximum GPM set points and allow field adjustment of the maximum allowable flow. The flow limiter shall allow the valve to retain the full range of flow control travel independent of the flow limit setting.
- 4) Valves shall have a linear flow characteristic.
- 5) The valves shall be provided with actuators by the same manufacturer factory installed.
- 6) Approved Manufacturer(s). Siemens, Griswold, B

3. Valve Specification for Distribution Valves

a. Flanged Valves, line size 2 ½” to 6”

- 1) Controlled Media Specific Items

- a) Steam control valve shall be suitable for saturated steam to a maximum temperature of 337°F (170°C) and a maximum pressure of 100 psig (690 kPa). A Linear flow characteristic and stainless steel trim is recommended.
 - b) Water control valve shall be suitable for chilled water to a minimum of 32°F (0°C) and hot water to a maximum temperature of 250°F (120°C). A modified equal percentage flow characteristic is recommended. Bronze trim is recommended for operating differential pressures up to 25psi. Stainless steel trim is recommended for operating differential pressures up to 50psi.
 - c) Glycol Solutions control valve shall be suitable for 50% ethylene or propylene glycol solutions, chilled glycol/water solutions to a minimum of 20°F (-7°C) and hot glycol/water solutions to a maximum temperature of 250°F (120°C). A modified equal percentage flow characteristic is recommended. Bronze trim is recommended for operating differential pressures up to 25psi. Stainless steel trim is recommended for operating differential pressures up to 50psi.
- 2) General Construction Materials/Applicable
- a) Standards Pressure Class 125 control valve bodies shall be constructed of gray cast iron according to ASTM A126B, and shall meet requirements of ANSI B16.1, pressure class ANSI 125.
 - b) Pressure Class 250 control valve bodies shall be constructed of gray cast iron according to ASTM A126B, and shall meet requirements of ANSI B16.1, pressure class ANSI 250.
 - c) For Class 125 and Class 250 valve assemblies, flange dimensions shall be according to ANSI B16.1, and valve body flange-to-flange dimensions shall be according to ANSI/ISA S75.03.
 - d) The control valve flow rate (Cv) shall meet the requirements of ANSI/ISA S75.02.

- e) The control valve shall have a linear flow characteristic, according to ANSI/ISA S75.11.
 - f) The control valve shall have a modified equal percentage flow characteristic.
 - g) The control valve shall have a minimum rangeability of 100:1.
 - h) Valve shall meet the requirements of seat leakage Class IV (0.01%) according to ANSI/FCI 70.2, with no more than 125% of nominal force necessary to balance fluid forces applied to valve stem.
 - i) Chilled and Hot water valve stem packing shall be of a cartridge type and shall contain at least two EPDM o-rings.
 - j) Steam valve stem packing shall be of a spring-loaded cartridge type and shall contain at least seven Teflon v-rings and one EPDM o-ring
 - k) Control valve seat shall be made of stainless steel according to UNS S30300 or ASTM A582 Type 303, and plug shall be made of bronze according to UNS C84400.
 - l) Control valve seat and plug shall be made of stainless steel according to UNS S30300, or ASTM A582 Type 303.
 - m) Valve stem shall be made of polished stainless steel according to ASTM A581/A or ASTM A582/A.
- b. Threaded Valves, line size ½” to 2”
- 1) Controlled Media Specific Items
 - a) The control valve shall be suitable for saturated steam to a maximum temperature of 337°F (170°C) and a maximum pressure of 100 psig (690 kPa). A Linear flow characteristic and stainless steel trim is recommended.
 - b) The control valve shall be suitable for chilled water to a minimum of 32°F (0°C) and hot water to a

maximum temperature of 250°F (120°C). A modified equal percentage flow characteristic is recommended. Bronze or brass trim is recommended for operating differential pressures up to 25psi. Stainless steel trim is recommended for operating differential pressures up to 50psi.

- c) The control valve shall be suitable for 50% ethylene or propylene glycol solutions, chilled glycol/water solutions to a minimum of 20°F (-7°C) and hot glycol/water solutions to a maximum temperature of 250°F (120°C). A modified equal percentage flow characteristic is recommended. Bronze or brass trim is recommended for operating differential pressures up to 25psi. Stainless steel trim is recommended for operating differential pressures up to 50psi.

2) General Construction Materials/Applicable Standards

- a) Control valve bodies shall be constructed of cast bronze according to UNS C84400 or forged brass according to UNS C37700, and shall meet requirements of ANSI B16.1, pressure class ANSI 250.
- b) Threaded connection specifications shall be according to ANSI B2.1.
- c) The control valve flow rate (Cv) shall meet the requirements of ANSI/ISA S75.02.
- d) The control valve shall have a linear flow characteristic, according to ANSI/ISA S75.11.
- e) The control valve shall have a modified equal percentage flow characteristic..
- f) The control valve shall have a minimum rangeability of 100:1.
- g) Valve shall meet the requirements of seat leakage Class IV(0.01%) according to ANSI/FCI 70.2, with no more than 125% of nominal force necessary to balance fluid forces applied to valve stem.

- h) Valve stem packing shall be of a cartridge type and shall contain at least two EPDM o-rings.
- i) Valve stem packing shall be of a spring-loaded cartridge type and shall contain at least three Teflon v-rings and one EPDM o-ring.
- j) Control valve seat shall be made of bronze according to UNS C84400 or stainless steel according to UNS S30300 or ASTM A582 Type 303, and plug shall be made of bronze according to UNS C84400 and/or brass according to UNS C36000 or C37700.
- k) Control valve seat and plug shall be made of stainless steel according to UNS S30300, or ASTM A582 Type 303.
- l) Valve stem shall be made of polished stainless steel according to ASTM A581/A or ASTM A582/A.

4. Valve Specification for Terminal Unit Valve

a. Threaded Valves, line size ½” to 1”

1) Controlled Media Specific Items

- a) The control valve shall be suitable for saturated steam to a maximum temperature of 250°F (120°C) and a maximum pressure of 15 psig (103.5 kPa). A linear flow characteristic and stainless steel trim is recommended.
- b) The control valve shall be suitable for chilled water to a minimum of 32°F (0°C) and hot water to a maximum temperature of 250°F (120°C). Bronze or brass trim is recommended for operating differential pressures up to 25psi. Stainless steel trim is recommended for operating differential pressures up to 50psi.
- c) The control valve shall be suitable for 50% ethylene or propylene glycol solutions, chilled glycol/water solutions to a minimum of 32°F (0°C) and hot glycol/water solutions to a maximum temperature of 250°F (120°C). Bronze or brass trim is

recommended for operating differential pressures up to 25psi. Stainless steel trim is recommended for operating differential pressures up to 50psi.

- 2) General Construction Materials/Applicable Standards
 - a) Control valve bodies shall be constructed of cast bronze according to UNS C84400 or forged brass according to UNS C37700, and shall meet requirements of ANSI B16.1, pressure class ANSI 250.
 - b) Threaded connection specifications shall be according to ANSI B2.1.
 - c) The control valve flow rate (Cv) shall meet the requirements of ANSI/ISA S75.02.
 - d) The control valve shall have a modified equal percentage flow characteristic, according to ANSI/ISA S75.11.
 - e) The control valve shall have a minimum rangeability of 100:1 on valves with a Cv value greater than or equal to 1.0 and a minimum rangeability of 50:1 on valves with a Cv value less than 1.0.
 - f) Valve shall meet the requirements of seat leakage Class IV (0.01%) according to ANSI/FCI 70.2, with no more than 125% of nominal force necessary to balance fluid forces applied to valve stem.
 - g) Chilled water, Hot water, and Steam valve stem packing shall contain at least two EPDM o-rings.
 - h) Control valve seat shall be made of stainless steel according to UNS S30300, or ASTM A582 Type 303 and plug shall be made of bronze according to UNS C84400 and/or brass according UNS C36000 or C37700.
 - i) Control valve seat and plug shall be made of stainless steel according to UNS S30300, or ASTM A582 Type 303.

- j) Valve stem shall be made of polished stainless steel according to ASTM A581/A or ASTM A582/A

5. Valve Specification for Characterized Ball Valves

a. Threaded Valves, line size ½” to 2”

1) Controlled Media Specific Items

- a) The control valve shall be suitable for chilled water to a minimum of 35°F (2°C) and hot water to a maximum temperature of 250°F (121°C).
- b) The control valve shall be suitable for up to 50% ethylene or propylene glycol solutions, chilled glycol/water solutions to a minimum of 35°F (2°C) and hot glycol/water solutions to a maximum temperature of 250°F (121°C).

2) General Construction Materials/Applicable Standards

- a) Control valve bodies shall be constructed of forged brass according to ASTM B283 (CuZn39Pb2 or equivalent), and shall meet requirements of ANSI 250 and 600WOG pressure classes.
- b) Inlets and outlets shall be clearly marked on the valve bodies.
- c) Valve ball shall consist of nickel-plated brass, chrome-plated brass or stainless steel.
- d) End connections shall be NPT internally threaded according to ANSI B1.20.1.
- e) The control valve flow rate (Cv) shall meet the requirements of ANSI/ISA S75.02.
- f) The control valve shall have an equal percentage flow characteristic, according to ANSI/ISA S75.11. A glass filled PTFE V port insert shall establish the flow coefficient of the valve. The V port shall be retained by the valve body itself, not requiring additional retainers components. Manufacturer may also provide a glass filled polymer ball insert, as an integral part of the ball, for modulating flow

applications. Flow coefficient adapters installed after final assembly of the valve shall not be allowed.

- g) Valve shall meet the requirements of ANSI Class IV (0.01% of rated Cv) seat leakage, or better, according to ANSI/FCI 70.2, at the specified close-off pressure.
- h) Chilled and Hot water valve shall have a blow-out proof stem with two EPDM (peroxide cured) O-rings. External stem retainers will not be allowed.
- i) Valve stem shall be made of brass or stainless steel.
- j) Valve shall have the ability to be manually operated in the event of a power failure.

6. Automatic Control Valve Actuators:

a. Electronic Valve Actuators

1) Applicable Standards

- a) 24V valve actuator shall be identified as a Class 2 operating device, according to NEC, Article 725.
- b) 120V valve actuator shall be identified as a Class 1 operating device, according to NEC, Article 725.
- c) The valve actuator shall be tested and listed by Underwriters Laboratories according to UL873, and shall bear the UL and cUL approval symbols.
- d) The valve actuator shall be designed and tested to NEMA 1 standards, according to NEMA 250.

2) Direct Coupled

- a) The control valve actuator shall be directly coupled to the valve, with no intermediary linkage kit required, to facilitate repair and/or replacement.
- b) The control valve actuator shall be equipped with a manual override feature, allowing operation of the control valve upon loss of control power or signal,

without the aid of a separate tool or auxiliary power supply.

- 3) Fail Safe operation
 - a) Upon power failure or loss of control signal, the valve actuator shall return to a fail-safe operating position by means of a mechanical spring.
 - b) Upon power failure or loss of control signal, the valve actuator shall return to a fail-safe operating position by self-contained electronic means.
 - c) Upon power failure, the valve actuator shall maintain its last controlled position (fail in place).
- 4) Visual position indication
 - a) The valve actuator shall provide indication of valve stem position, clearly visible from a distance of 15ft. (4.5m).
- 5) Ball Valve Actuators Torque Requirement
 - a) The control valve actuator shall provide minimum torque required for full valve shutoff position.

H. AIR VELOCITY SENSORS

1. Air velocity sensors shall make measurements using a thin film thermal anemometer. Sensor shall deliver a 0 to 10 volt or 4-20mA (selectable) output signal, corresponding to a range of 0 to 3000 fpm. Sensor measuring range must be adjustable to optimize reading.

I. AIRFLOW MEASURING STATIONS

1. Fan Inlet Type:
 - a. Provide where indicated on the plans, airflow measuring stations of fan inlet type. Airflow traverse probes shall be suitable for mounting in the inlet bell(s) of the indicated fan.
 - b. Probes shall be provided with the appropriate end support brackets for mounting in the inlet bell(s). Where fans are of dual inlet type, two sets of inlet probes must be provided.
 - c. Fan inlet probes shall be provided with the fittings to allow for the connection of control tubing to the probe assemblies.

- d. Probes shall be capable of operating with an accuracy of 3% of actual volume over the fan operating range.
- e. The installation of the airflow measuring stations shall be coordinated with sheet metal contractor to ensure actual accuracy and accessibility for maintenance.
- f. The installation of the airflow measuring stations shall be coordinated with sheet metal contractor to ensure actual accuracy and accessibility for maintenance.
- g. Fan inlet probes shall be Tek-Air T-FP7000, Air Monitor or Ebtron

2. Duct Mounted Type:

- a. Provide where indicated on the plans, airflow traverse probes of the insertion type, capable of continuously measuring air volume in the duct served.
- b. Probes shall utilize multiple total and suction pressure measurement points, located along the length of the probe surface in accordance with ASHRAE recommendations for duct traversing.
- c. The probes shall provide measurement accuracy within $\pm 2\%$ of actual velocity when used with the appropriate conversion formula.
- d. Probes shall be of cylindrical cross section and shall indicate no more than a $\pm 3\%$ percent deviation from the centerline velocity at a yaw angles up to 30 degrees.
- e. Probes shall be constructed of extruded aluminum, unless dictated otherwise by service requirements. Probes over sixteen inches long shall be supported on the insertion end.
- f. Probe quantities for each location shall be sufficient to meet ASHRAE recommendations.
- g. The pressure drop created by the traverse probes shall not be greater ten percent of the velocity pressure at the maximum design flow.
- h. The probes shall not amplify sound levels in the duct. The manufacturer shall provide submittal data indicating the developed

differential pressure and pressure loss at the minimum and maximum design air flows for each duct location.

- i. Traverse probes shall be Tek-Air model T-FP5000, Air Monitor or Ebtron

J. BINARY TEMPERATURE DEVICES

1. Line-voltage space thermostat:

- a. Line-voltage thermostats shall be bimetal-actuated, snap acting SPDT contact, enclosed, UL listed for electrical rating. The thermostat cover shall provide exposed setpoint adjustment knob. The thermostat shall operate within the 55°F to 85°F setpoint range, with 2°F maximum differential.

2. Low-temperature safety thermostat:

- a. Low-limit air stream thermostats shall be UL listed, vapor pressure type, with a sensing element of 20 ft. minimum length. Element shall respond to the lowest temperature sensed by any 1 ft. section. The low-limit thermostat shall be automatic reset, SPDT type.

3. Aquastat:

- a. Strap-on type thermostats shall be provided for low or high temperature limit service on hot water or steam condensate pipes. The thermostats shall be UL Listed, with a liquid-filled bulb type sensing element and capillary tubing. The thermostat shall operate within the 20°F to 120°F, or 100°F to 240°F, setpoint range, with an adjustable 6°F differential.
- b. The low-limit thermostat shall be automatic reset, snap acting SPDT type with concealed setpoint adjustment.

K. TEMPERATURE SENSORS.

- 2. Provide the following instrumentation as required by the monitoring, control and optimization functions. All temperature sensors shall use platinum RTD elements only, nickel or silicon are not acceptable. All control signals shall be via a 4-20 mA loop.

3. Room Temperature:

- a. Temperature monitoring range +40/+90°F (+40/120°F for high temp alarms)

- b. Installation adjustments none required
- c. Calibration adjustments none required
- d. Factory calibration point 32°F
- e. Accuracy at calibration point +/- 0.7°F

4. Liquid Immersion Temperature

- a. Temperature monitoring range +30/+250°F, +20/+70°F or +32/+212°F
- b. Installation adjustment none required
- c. Calibration adjustments none required
- d. Factory calibration point 32°F
- e. Accuracy at calibration point +/- 0.54°F

5. Duct (Single Point) Temperature

- a. Temperature monitoring range +20/+120°F or +30/+250°F
- b. Installation adjustments none required
- c. Calibration adjustments none required
- d. Factory calibration point 70°F
- e. Accuracy at calibration point +/- 0.54°F

6. Duct (Averaging) Temperature

- a. Temperature monitoring range +20/+120°F
- b. Installation adjustments none required
- c. Calibration adjustments none required
- d. Factory calibration point 32°F
- e. Accuracy at calibration point +/- 0.54°F

7. Outside Air Temperature

- a. Temperature monitoring range -58/+122°F
- b. Installation adjustments none required
- c. Calibration adjustments none required
- d. Factory calibration point 32°F
- e. Accuracy at calibration point +/- 0.54°F

L. DEW POINT/HUMIDITY SENSORS

1. Outside Air Dew Point Temperature

- a. Dew point monitoring range -40/+115°F DP, 12% to 99% rh
- b. Output signal 4-20 mA
- c. Calibration adjustments none required
- d. Factory calibration point 70°F

- e. Accuracy at calibration point +2.0°F DP
2. Room/duct Relative Humidity
 - a. Sensor Humidity range 0 to 100%
 - b. Operating temperature 15°F to +170°F
 - c. Accuracy +2% rh
 - d. Sensing element Capacitive sensor
 - e. Output signal 4-20 mA DC
 - f. Installation adjustments none required
 - g. Operating temperature 15°F to +170°F
 - h. Voltage requirement 12-36 Vdc
 3. Duct Hygrostat (Specify Siemens QFM81.2)
 - a. Humidity setpoint range 15 to 95%
 - b. Switching differential +/- 4%
 - c. Output signal On/off
 - d. Setpoint Exposed or concealed
 - e. Switch type Single pole microswitch
 - f. Operating temperature 32 to 158°F
 - g. Agency listing UL (low voltage)
 4. Condensation Sensor (Specify Siemens QXA2000 or Sauter EGH 102)
 - a. Switching point on RH increase 95%
 - b. Operating Voltage 24 Vac/Vdc
 - c. Operating Temperature -12 to 122°F
 - d. Operating Humidity 5 to 95%
 - e. Relay Output NO/NC dry contact
 - f. Switching Differential 5% rh
 - g. Response time (max) 3 minutes
 - h. Power Consumption (max) 1 VA

M. PRESSURE SENSORS

1. Air Static Pressure Sensor
 - a. Duct Static range -.5 to + 7.5" wg
 - b. Accuracy + .05" wg
 - c. Output signal 4 - 20 mA
2. Air Differential Pressure Sensors
 - a. Transducer shall have linear output signal with adjustable zero point
 - b. Air differential pressure transducer shall have a polycarbonate housing with integral mounting tabs and ceramic sensing elements.

Minimum long term stability shall be +/- 0.5% of full scale. Transducer shall be complete with 4 to 20 mA output that is protected against short circuits and polarity reversal.

N. WATER DIFFERENTIAL PRESSURE SENSOR

1. Transducer shall have linear output signal. Zero and span shall be not require field adjustment.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage.
3. Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 4 to 20 mA output, required mounting brackets, and block and bleed valves.
4. Water differential pressure transducer shall have an aluminum housing with stainless steel wetted parts and ceramic sensing elements. Transducer shall be complete with 4 to 20 mA output, that is protected against short circuits and polarity reversal.
5. Provide industrial grade differential pressure sensors for all differential pressure bypass valves. Sensor shall be factory calibrated for operating range and rated for system pressure. Provide manufacturers standard 6061-T6511 aluminum, 3 valve manifold. Output shall be 4-20 mA. Sensor shall be Siemens QBE3190 or pre-approved equal.

O. DIFFERENTIAL PRESSURE SWITCHES.

1. Water Differential Pressure Switch
 - a. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum), NEMA 1 enclosure, with scale range and differential suitable for intended application or as shown.
 - b. The differential switches shall meet the following requirements:
 - 1) Range 8 to 70 psi
 - 2) Differential 3 psi
 - 3) Maximum differential pressure 200 psi
 - 4) Maximum pressure 325 psi
2. Air Differential Pressure Switch

- a. Differential pressure switches shall be diaphragm type, with die-cast aluminum housing and adjustable setpoint. Switch rating shall be a minimum 5 amps at 120 Vac. Switches shall be SPDT and be used for fan status as specified in the point schedule. Switch pressure range shall be suited for application (e.g., filter 0-2.0", fan status 0-5.0", etc.).

P. WATER LEAK DETECTION SYSTEM

1. Single point leak detector

- a. The alarm module, TTC, shall monitor up to a maximum of 50 feet of sensing cable. The alarm module shall indicate that water has contacted the sensing cable by sounding an audible alarm and actuating an output relay. The relay shall remain activated until the cable is dry and the module is reset.
- b. The alarm module shall be capable of detecting the presence of a 1-inch leak anywhere along the cable with a repeatability of +/- 1%.
- c. The alarm module shall continuously monitor the sensing cables and interconnecting cables for continuity. Any break in the cable shall generate an audible alarm, activate an output relay and activate a "continuity" LED on the face of the module.
- d. The alarm module shall have LED's indicating "power" (green), "alarm" (red) and "continuity" (yellow).
- e. The alarm module shall be powered by Emergency power.
- f. The module shall be mounted in a field equipment cabinet.

2. Water sensing cable

- a. The water sensing cable (TT-1000) shall detect the presence of water and pinpoint its location. The cable shall consist of four wires: Two sensor wires, a continuity wire and a return wire. All four wires shall be coated and insulated with a fluoropolymer and wound helically around a fluoropolymer core. The cable shall have a breaking strength, including connectors, of at least 70 pounds, per ASTM D-638. The cable shall have an abrasion resistance of >65 cycles, per UL 719.

- b. The sensing cable shall offer distributed sensing with the ability to detect the location of water at any point along the length of the cable. The cable shall be flexible, and carry less than 24 Vdc under normal conditions.
 - c. The system shall not alarm when in contact with any metallic equipment such as drip pans, floor tile supports, conduit, etc.
 - d. The cable shall be available in modular, preconnectorized lengths of 5, 10, 15, 25 and 50 feet. Field splicing shall not be acceptable.
 - e. The cable shall be UL 910 rated and plenum rated per NEC 725-2(b).
 - f. Provide two sets of test instrumentation to owner.
3. Jumper cable
- a. Jumper cable shall be used where leak detection cable is not required but continuity is required (in raceways between alarm module and floor surface, etc.). The jumper cable shall be plenum rated and jacketed with fluoropolymer materials, per NEC 725-2(b). The jumper cable shall consist of four different colors (Y, B, R, G), insulated 18 AWG wires and shall be available in preconnectorized lengths of 5, 10, 15, 25 and 50 feet.
4. Accessories
- a. Provide all end connectors, leader cables, hold down clips, caution tags, spray adhesive (3M 90M) as required.
5. Graphic display map
- a. Provide a graphic display map for each room served. The map shall be a 1/8 in. = 1.0 ft scaled drawing of the area served, indicating actual equipment locations, floor tile and other points of reference. The actual cable routing shall be clearly marked on the map with actual scaled distances every 10 feet.
 - b. A dynamic graphic display, equivalent to the aforementioned map, shall be duplicated on the BMS operator workstation. The area in alarm (within 5 feet) shall blink in red until the alarm is cleared.
6. Performance

- a. A maximum wetted area of 2 inches of cable, at any point along the entire length of cable, shall activate an alarm.
- b. The system shall be continuously monitored for continuity. The loss of continuity shall cause an alarm within 5 seconds.
- c. The cable shall be capable of being cleaned with a clean dry cloth, in place.
- d. The cable shall dry and reset the module immediately upon removal from free water. No shaking, wiping or mechanical action shall be required.

7. Installation

- a. All system components shall be installed in accordance with the manufacturer's recommendations. The manufacturer shall provide necessary installer training and supervision as required.
- b. The cable shall be installed on clean, dry finished surfaces only (coordinate access and schedule installation as required) after the possibility of physical damage has been eliminated. The cable shall be fastened to the surface it is monitoring every 4 feet with hold down clips and spray mastic adhesive. Hold down clip installation shall be subject to spot checks during commissioning. If any clip fails, all other clips shall be re-attached and retested, at no additional cost.
- c. The system shall be commissioned prior to acceptance. Submit a test procedure for approval.

8. Warranty

- a. All equipment shall be warranted to the same extent as the BMS system, or per the manufacturer's warranty, whichever is greater.

Q. AUDIO/VISUAL ALARM UNITS

- 1. Provide 1" x 3" translucent illuminated rectangular alarm light ("BMS Alarm"), sonalert horn (hidden), silence switch with stainless steel cover plate to match desk surface. When any BMS alarm occurs (as coordinated with facilities personnel), the alarm light shall flash once per second (adjustable) and the horn shall sound. When the silence switch is pushed, the horn will silence and the pilot light shall light continuously until alarm is cleared.

2. The BMS shall monitor the alarm light, horn and silence switch status.
3. Provide 1/8 inch high engraved and painted lettering for operational instructions as required by the owner on the cover plate.

R. WATER BTU METERS

1. Provide insertion type water flow meters designed to mount through a fully open 1 inch full bore ball valve supplied by flow meter manufacturer. Meter flow range shall be 2-40 feet/second for liquid service. Meter linearity shall be +/-1% for a 10:1 range. Repeatability shall be .10%. All wetted parts shall be constructed of stainless steel, bearings shall be tungsten carbide. Housing and flange shall be carbon steel. Housing pressure rating shall be 350 psig. A DC powered transmitter shall be mounted on the flow meter. Flow transmitter output shall be 4-20 mA linear with flow. Transmitter input shall be from magnetic pickup. Transmitter accuracy shall be .25% of span. The water flow meter shall be Onicon F 1220 or equal.
2. Provide supply and return temperature sensors for "Delta-T" calculation of BTU consumption. Monitor total accumulated BTUs, current BTUs, monthly total BTUs, and yearly total BTUs for each location specified or shown.
3. Provide isolation valve kit to allow removal and servicing of meter while system is operating.
4. All devices associated with the BTU meters serving the chilled water and ice storage system shall be suitable for the extreme environmental conditions. The devices shall properly operate with the specified accuracy and shall not be affected by the media, or by the environment that includes but not limited to low temperatures (10°F), temperature fluctuations and condensation. Control panel enclosures and electronics shall meet the aforementioned requirements or located strategically to ensure proper operation.

S. WATER FLOW SWITCHES

1. Shall use either a microswitch type (QVE1900U) or magnetic reed contact type (OVE1901U) flow switch.
2. UL Listed for low voltage.
3. Supports media temperature up to 230°F.

T. INDOOR AIR QUALITY (CO2/VOC/TEMP/RH) SENSORS

1. Provide indoor air quality sensors to monitor Carbon Dioxide (CO₂) and/or Volatile Organic Compound (VOC) levels, and /or Temperature and Humidity.
2. The CO₂ sensor shall be of microprocessor-based non-dispersive infrared type (NDIR) with an additional integrated reference light source.
3. The CO₂ sensors shall have no more than 1% drift during the first year of operation and minimal drift thereafter so that no calibration will be required.
4. The units shall be wall or duct mounted type as indicated on plans and in the sequence of operation.
5. Wall mounted sensors shall be provided with white plastic cover, without LED indicators.
6. Duct and Wall mounted sensors shall be suitable for zones with 24/7 occupancy
7. Duct and Wall mounted sensors with Temperature shall have an option for active or passive temperature outputs (based on part number)
8. Duct mounted sensors shall be provided without the need for a separate aspirator box.
9. The VOC sensor shall have automatic self calibrating capability to ensure accuracy.
10. The sensor shall meet the following requirements:
 - a. Operating voltage: 24 Vac +/- 20%, or 15 to 35Vdc
 - b. Frequency: 50/60 Hz
 - c. Power consumption: max. 6 VA
 - d. CO₂ measuring range: 0 – 2000 ppm
 - e. Tolerance: +/- 50 ppm
 - f. Output: 0 – 10 Vdc or 0 – 5 Vdc Field configurable
 - g. Output (passive T, selectable)pt100, pt1000, Ni1000, NTC 10K
 - h. Calibration: none required
 - i. VOC measurement range: 0 – 10V VOC
 - j. Permissible air velocity in duct: <26.2 ft/s.

11. The sensors shall be model Siemens QPA1000, QPA2000, QPM2100, or QPM1100 Series.

U. RELAYS.

1. Control relays shall be UL listed plug-in type with dust cover and LED “energized” indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
2. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable $\pm 200\%$ (minimum) from setpoint shown on plans. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure when not installed in local control panel.

V. OVERRIDE TIMERS.

1. Override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration as required by application. Provide 0- to 6-hour calibrated dial unless otherwise specified. Timer shall be suitable for flush mounting on control panel face and located on local control panels or where shown.
2. Current transmitters.
3. AC current transmitters shall be the self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4 to 20 mA two-wire output. Unit ranges shall be 10A, 20A, 50A, 100A, 150A, and 200A full scale, with internal zero and span adjustment and $\pm 1\%$ full-scale accuracy at 500 ohm maximum burden.
4. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA Recognized.
5. Unit shall be split-core type for clamp-on installation on existing wiring.

W. CURRENT TRANSFORMERS.

1. AC current transformers shall be UL/CSA Recognized and completely encased (except for terminals) in approved plastic material.
2. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5A full-scale output.
3. Transformers shall be fixed-core or split-core type for installation on new or existing wiring, respectively.

X. VOLTAGE TRANSMITTERS.

1. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4 to 20 mA output with zero and span adjustment.
2. Two (2) Ranges shall include 100 to 130 Vac, 200 to 250 Vac, 250 to 330 Vac and 400 to 600 Vac full-scale, adjustable, with $\pm 1\%$ full-scale accuracy with 500 ohm maximum burden.
3. Transmitters shall be UL/CSA Recognized at 600 Vac rating and meet or exceed ANSI/ISA S50.1 requirements.

Y. VOLTAGE TRANSFORMERS.

1. AC voltage transformers shall be UL/CSA Recognized, 600 Vac rated, complete with built-in fuse protection.
2. Transformers shall be suitable for ambient temperatures of 4°C to 55°C (40°F to 130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and a 5 VA load.
3. Windings (except for terminals) shall be completely enclosed with metal or plastic material.

Z. POWER MONITORS.

1. Power monitors shall be the three-phase type furnished with three-phase disconnect/shorting switch assembly, UL Listed voltage transformers, and UL Listed split-core current transformers.
2. They shall provide a selectable rate pulse output for kWh reading and a 4 to 20 mA output for kW reading. They shall operate with 5A current inputs with a maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.

AA. CURRENT SWITCHES.

1. Current-operated switches shall be self-powered, solid-state with adjustable trip current. The switches shall be selected to match the current of the application and output requirements of the DDC system.

BB. LOCAL CONTROL PANELS.

1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with (hinged door) key-lock latch and removable sub panels. A single key shall be common to all field panels and sub panels.
2. Interconnections between internal and face mounted devices shall be prewired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings.
3. Provide ON/OFF power switch with overcurrent protection for control power sources to each local panel.

2.11 Communication and Control Wiring

A. General:

1. Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 16 unless otherwise noted herein.
- 2.
3. Control cabling shall be installed in EMT where exposed or inaccessible. Open plenum rated cable shall be installed where concealed and accessible.
4. All insulated wire to be copper conductors, UL labeled for 90°C minimum service.

B. Wire Sizing and Insulation

1. Wiring shall comply with minimum wire size and insulation based on services listed below:

a.	Service	Minimum Gage/Type Insulation Class	
b.	AC 24V Power	12 Ga Solid	600 Volt
c.	DC 24V Power	10 Ga Solid	600 Volt
d.	Class 1	14 Ga Stranded	600 Volt
e.	Class 2	18 Ga Stranded	300 Volt
f.	Class 3	18 Ga Stranded	300 Volt

Provide plenum-rated cable when open cable is permitted in supply or return air plenum.

C. Power Wiring:

1. 115V power circuit wiring above 100 feet distance shall use minimum 10 gage.
 2. 24V control power wiring above 200 feet distance shall use minimum 12 gage.
- D. Control Wiring:
1. Digital Input/Output wiring shall use Class 2 twisted pair, insulated.
 2. Analog inputs shall use Class 2 twisted shielded pair, insulated and jacketed and require a grounded shield.
 3. Actuators with tri-state control shall use three (3) conductors with same characteristics..
- E. Communication Wiring
1. Ethernet Cable shall be minimum CAT5.
 2. Secondary level network shall be 24 awg, TSP, low capacitance cable.
- F. Approved Cable Manufacturers:
1. Wiring from the following manufacturers which meet the above criteria shall be acceptable:
 - a. Anixter
 - b. Belden

2.12 Fiber Optic Cable System

- A. Fiber Optic cable: Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. The sheath shall be UL Listed OFNP in accordance with NEC Article 770. The optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125mm for use in 10/100 MB fiber optic networks.
- B. Connectors: All optical fibers shall be field-terminated with ST type connectors. Connectors shall have hot melt and polish or epoxy and polish type connectors. No Mechanical crimp type permitted.
- C. Outdoor/underground installation of Fiber Optic cable shall be gel coated and rated for outdoor/underground installation.

- D. Four strands is the minimum required for each run, two for the link and two as spares.
- E. 1 GB Ethernet networks shall be single mode fiber for lengths over 275 m. Single mode Ethernet requires two strands of 9 um cable.

PART 3 – EXECUTION

3.01 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 architect/engineer 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 engineer 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 engineer and shall obtain written instructions for any changes necessary to accommodate the contractor’s work with the work of others.

3.02 Protection:

- A. The contractor shall protect all work and material from damage by its employees and/or subcontractors and shall be liable for all damage thus caused.
- B. The contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted.

3.03 Coordination:

- A. Site
 - 1. The project coordination between trades is the responsibility of the prime contractor who is the one tier higher contractual partner such as mechanical contractor, general contractor, construction manager, owner or owner’s representative as applicable.
 - 2. The controls contractor shall follow prime contractor’s job schedule and coordinate all project related activities through the prime contractor except

otherwise agreed or in minor job site issues. Reasonable judgment shall be applied.

3. Where the work will be installed in close proximity to, or will interfere with, work of other trades, the contractor shall assist in working out space conditions to make a satisfactory adjustment.
4. If the contractor deviates from the job schedule and installs work without coordinating with other trades, so as to cause interference with work of other trades, the contractor shall make the necessary changes to correct the condition without extra charge.
5. Coordinate and schedule work with all other work in the same area, or with work that is dependent upon other work, to facilitate mutual progress.

B. Submittals.

1. Refer to the *Submittals* section in *PART 1 – GENERAL* of this specification for requirements.

C. Life Safety

1. Duct smoke detectors required for air handler shutdown are supplied under Division 16 of this specification. The contractor shall interlock smoke detectors to air handlers for shutdown as described in the *Sequences of Operation* section in *PART 2 – PRODUCTS* of this specification.
2. Smoke dampers and actuators required for duct smoke isolation are provided under a Section of Division 15. The contractor shall interlock these dampers to the air handlers as described in the *Sequences of Operation* section in *PART 2 – PRODUCTS* of this specification.
3. Fire/smoke dampers and actuators required for fire rated walls are provided under another Section of Division 15. Control of these dampers shall be by Division 16.

D. Coordination with controls specified in other sections or divisions.

1. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the contractor as follows:
 - a. All communication media and equipment shall be provided as specified in the *Communications* section in *PART 2 – PRODUCTS* of this specification.

- b. Each supplier of controls product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this section.
- c. The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this section and those provided under other sections or divisions of this specification.
- d. The contractor is responsible for providing all controls described in the contract documents regardless of where within the contract documents these controls are described.
- e. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the contract documents.

3.04 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 all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of 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 acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

3.05 Field Quality Control:

- A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in *PART I – GENERAL* of this specification.
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.

3.06 Existing Equipment:

- A. Unless otherwise directed, the contractor is not responsible for the repairs or replacement of existing energy equipment and systems, valves, dampers, or actuators. Should the contractor find existing equipment that requires maintenance, the engineer is to be notified immediately.

3.07 Wiring:

- A. All control and interlock wiring shall comply with national and local electrical codes and Division 16 of this specification. Where the requirements of this section differ from those in Division 16, the requirements of this section shall take precedence.
- B. All NEC Class 1 (line voltage) wiring shall be UL Listed in approved conduit according to NEC and Division 16 requirements.
- C. All low-voltage wiring shall meet NEC Class 2 requirements. (Low-voltage power circuits shall be sub-fused 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 conduit may be used provided that cables are UL Listed for the intended application. For example, cables used in ceiling plenums shall be UL Listed specifically for that purpose.
- E. All wiring in mechanical, electrical, or service rooms—or where subject to mechanical damage—shall be installed in conduit.
- F. Do not install Class 2 wiring in conduit 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 conduit containing tubing.
- H. Where plenum rated cable 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 rated cable is used without conduit, it shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical conduits, piping, or ceiling suspension systems.
- J. All wire-to-device connections shall be made at a terminal block or wire nut. All wire-to-wire connections shall be at a terminal strip or wire nut.

- 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 120V. If only higher voltages are available, the contractor shall provide step-down transformers or interposing relays.
- M. All plenum rated wiring shall be installed as continuous lengths, with no splices permitted between termination points.
- N. All wiring in conduit shall be installed as continuous lengths, with no splices permitted between termination points or junction boxes.
- O. Maintain fire rating at all penetrations. Install plenum wiring in sleeves where it passes through walls and floors.
- P. Size and type of conduit 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.
- Q. Include one pull string in each conduit 3/4 inches or larger.
- R. Control and status relays are to be located in designated enclosures only. These enclosures can include packaged equipment control panel enclosures unless they also contain Class 1 starters.
- S. Conceal all conduit, except within mechanical, electrical, or service rooms. Install conduit to maintain a minimum clearance of 15 cm (6 in.) from high-temperature equipment (e.g., steam pipes or flues).
- T. Secure conduit with conduit clamps fastened to the structure and spaced according to code requirements. Conduit and pull boxes may not be hung on flexible duct strap or tie rods. Conduits may not be run on or attached to ductwork.
- U. Adhere to this specification's Division 16 requirements where conduit crosses building expansion joints.
- V. 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.
- W. Flexible metal conduits and liquid-tight, flexible metal conduits shall not exceed 1 m (3 ft) in length and shall be supported at each end. Flexible metal conduit less than 1/2 inches electrical trade size shall not be used. In areas exposed to

moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

- X. Conduit must be adequately supported, properly reamed at both ends, and left clean and free of obstructions. Conduit 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.

3.08 Communication Wiring:

- A. The contractor shall adhere to the items listed in the *Wiring* section in *PART 3 – EXECUTION* of this 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 raceway and enclosures containing Class 1 or other Class 2 wiring.
- D. Maximum pulling, tension, and bend radius for 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 the 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 lightning arrestor shall be installed according to the 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."

3.09 Fiber Optic Cable System:

- A. Maximum pulling tensions as specified by the cable manufacturer shall not be exceeded during installation. Post-installation residual cable tension shall be within cable manufacturer's specifications.

- B. All cabling and associated components shall be installed in accordance with manufacturers' instructions. Minimum cable and unjacketed fiber bend radii, as specified by cable manufacturer, shall be maintained.
- C. All terminations need to be made into a patch panel, designed for such use. Free air terminations with patch panels are prohibited.

3.10 Installation Of Sensors:

A. General:

1. Install sensors in accordance with the manufacturer's recommendations.
2. Mount sensors rigidly and adequately for the environment within which the sensor operates.
3. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
4. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
5. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type.
6. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across the full face of the coil.
7. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
8. Install outdoor air temperature sensors on north wall, complete with sun shield at designated location.

B. Room Instrument Mounting

1. Room instruments, including but not limited to wall mounted thermostats and sensors located in occupied spaces shall be mounted 53 inches above the finished floor unless otherwise shown.

C. Instrumentation Installed in Piping Systems

1. Thermometers and temperature sensing elements installed in liquid systems shall be installed in thermowells.
2. Gauges in piping systems subject to pulsation shall have snubbers.

3. Gauges for steam service shall have pigtail fittings with isolation valve.

D. Duct Smoke Detectors

1. Duct smoke detectors will be provided by the Fire Alarm System Contractor in supply and return air ducts in accordance with Division 16.
2. Contractor shall connect the DDC System to the auxiliary contacts provided on the Smoke Detector as required for system safeties and to provide alarms to the DDC system.

E. Occupancy Sensors

1. A sufficient quantity of occupancy sensors shall be provided to provide complete coverage of the area (room or space).
2. Occupancy sensors shall be installed in accordance with NFPA 70 requirements and the manufacturer's instructions.
3. Occupancy sensors shall not be located within 1.8 m (6 ft) of HVAC outlets or heating ducts.
4. PIR and dual-technology PIR/ultrasonic sensors shall not be installed where they can "see" beyond any doorway.
5. Ultrasonic sensors shall not be installed in spaces containing ceiling fans.
6. Sensors shall detect motion to within 0.6 m (2 ft) of all room entrances and shall not trigger due to motion outside the room.
7. The off-delay timer shall be set to [15][___] minutes unless otherwise shown.
8. All sensor adjustments shall be made prior to beneficial occupancy, but after installation of furniture systems, shelving, partitions, etc.
9. Each controlled area shall have one hundred percent coverage capable of detecting small hand-motion movements, accommodating all occupancy habits of single or multiple occupants at any location within the controlled room.

F. Temperature Limit Switch

1. A temperature limit switch (Low Temperature Detector) shall be provided to sense the temperature.

2. A sufficient number of temperature limit switches shall be installed to provide complete coverage of the duct section.
3. Manual reset limit switches shall be installed in approved, accessible locations where they can be reset easily.
4. The temperature limit switch sensing element shall be installed in a serpentine pattern and in accordance with the manufacturer's installation instructions.
5. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m² (1 ft of sensing element for each 1 ft²) of coil area.

G. Averaging Temperature Sensing Elements

1. Sensing elements shall be installed in a serpentine pattern.
2. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

H. Airflow Measuring Stations (AFMS)

1. Outside Air AFMSs shall be located downstream from the Outside Air filters.
2. Pitot Tube type AFMS shall not be used if the expected velocity measurement is below 3.5 m/s (700 fpm) [or for outside airflow measurements].

I. 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 the high-pressure tap to the 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.
6. Mount transducers in a location accessible for service without use of ladders or special equipment.
7. If the transmitter is wired in a homerun configuration to an AHU controller, the transmitter shall be located in the same enclosure as the air handling unit (AHU) controller(s) for the AHU serving the terminal units.

J. Water Differential Pressure Sensors

1. Differential pressure sensors shall be installed with valved taps into the piping to ensure serviceability without draining the system.
2. Sensors shall be mounted with bleed valves.
3. After sensor installation any air shall be eliminated using the bleed valves to ensure reading accuracy.
4. The sensors shall be located to ensure accessibility.

K. Relative Humidity Sensors

1. Relative humidity sensors in supply air ducts shall be installed at least 3 m (10 feet) downstream of humidity injection elements.

L. Flowmeters

1. The minimum straight unobstructed piping for the flowmeter installation shall be at least 10 pipe diameters upstream and at least 5 pipe diameters downstream and/or in accordance with the manufacturer's installation instructions.

M. Flow Switch

1. Use correct paddle length for pipe diameter.
2. Adjust flow switch in accordance with manufacturer's instructions.

3.11 Flow Switch Installation:

- A. Use correct paddle for pipe diameter.
- B. Adjust flow switch in accordance with manufacturer's instructions.

3.12 Actuators:

- A. 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° available for tightening the damper seals. 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.

3.13 WARNING LABELS AND IDENTIFICATION TAGS

- A. Equipment and Device labeling:
 - 1. Labels and tags shall be keyed to the unique identifiers shown on the as-built drawings.
 - 2. All Enclosures and DDC Hardware shall be labeled.
 - 3. Labels inside protective enclosures may be attached using adhesive, but shall not be hand written.

4. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

3.14 Identification Of Hardware And Wiring:

- A. Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

3.15 PROGRAMMING:

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free within the primary controller for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index. Point Naming standard shall be agreed upon between owner and BAS contractor. Refer to the *Submittals* section in *PART I – GENERAL* of this specification.
- C. Software Programming
 1. Provide programming for the system and adhere to the sequences of operation provided. The contractor also shall provide all other system programming necessary for the operation of the system, but not specified in this document. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation and be of different font and color in text editor. Use the appropriate technique based on one of the following programming types:
 - a. Text-based:
 - 1) Must provide actions for all possible situations
 - 2) Must be modular and structured
 - 3) Must be commented
 - 4) Must provide line by line programming and compilation wizard to allow for ease of editing.
 - b. Graphic-based:

- 1) Must provide actions for all possible situations.
- 2) Must provide programming and compilation wizard to allow for ease of editing.
- 3) Must be documented.

D. 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.
2. Show terminal equipment information on a “graphic” summary table. Provide dynamic information for each point shown.
3. The contractor shall provide all the labor necessary to install, initialize, 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.
4. Contractor shall provide necessary programming to create all reports referred to in *Operator Interface Software* section in *PART 1 – GENERAL* of this specification

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* section in *PART 3 – EXECUTION* of this specification. The engineer 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 sequences of operation through all modes of operation.
7. Demonstrate complete operation of operator interface.
8. 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 engineer and owner 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 engineer. 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 their 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.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.18 TRAINING

- A. Refer to Form 817 Article 1.20-1.08.14 subsection 3 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- A. Provide 16 hours of site specific training for Owner's operating personnel. Training shall include:
 - 1. Day-to-day Operators:
 - c. Proficiently operate the system
 - d. Understand control system architecture and configuration
 - e. Understand DDC system components
 - f. Understand system operation, including DDC system control and optimizing routines (algorithms)
 - g. Operate the workstation and peripherals
 - h. Log on and off the system
 - i. Access graphics, point reports, and logs
 - j. Adjust and change system setpoints, time schedules, and holiday schedules
 - k. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals
 - l. Understand system drawings and Operation and Maintenance manual
 - m. Understand the job layout and location of control components
 - n. Access data from DDC controllers and ASCs
 - o. Operate portable operator's terminals
 - 2. System Managers/Administrators:
 - a. Maintain software and prepare backups
 - b. Interface with job-specific, third-party operator software

- c. Add new users and understand password security procedures
- B. The instructor(s) shall be factory-trained instructors experienced in presenting this material.

END OF SECTION 230900

SECTION 230994 – SEQUENCE OF OPERATION

PART 1 – GENERAL

1.1. DESCRIPTION OF WORK

- A. The sequence of operation is hereby defined as the written manner and method by which HVAC systems and other building systems and equipment operate. This description includes automatic and manual control functions and includes operation(s), which are monitored, observed, trended, etc. and otherwise used to make decisions regarding system operation.
- B. Input/Output (I/O) points, which are required, are herein defined as those hardware and software points needed to achieve the described sequence of operation, measurement, monitoring, calculating and alarming. These are as shown on the Point Lists, and as described and/or shown on the contract drawings, and as described in all specification sections. The point's requirement is cumulative in its effect so as to be more complete and inclusive than any one cited source. The points shall be monitored, displayed, adjusted, trended, and/or alarmed at the POT and/or SOC.
- C. Adjustability of Settings: Declarations within the specifications of setpoints, differentials, times, alarm settings, and all other such settings are hereby understood to be adjustable at the Portable Operator's Terminal (POT) and/or School Operating Console (SOC). Settings provided are intended as an initial operating condition for system startup and configuration unless otherwise noted. Final settings determined in conjunction with other trades, such as the Test & Air Balancing Contractor, and during system startup and calibration shall be included in final system backed-up, sequence of operations and included in the owner's manual and close-out documentation.

1.2 DEFINITIONS

- A. Refer to the plans and specifications throughout for abbreviations and other references used to define objects, systems, and operations commonly used in this section to describe the sequences of operation. Common trade abbreviations might be used without reference.
- B. ACU: Air Conditioning Unit
- C. ACC: Air-Cooled Condenser
- D. AHU: Air Handling Unit
- E. BMS: Building Management System
- F. DDC: Direct Digital Controls
- G. DOAS: Dedicated Outside Air System
- H. HHL: Humidity High Limit

- I. NSB: Night Set Back Temperature
- J. NSU: Night Set Up Temperature
- K. VAV: Variable Air Volume

1.3 RELATED SECTIONS

- A. Division 23 Sections
- B. Division 26 Sections

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Sequence of Operation: Submit Shop Drawings for each of the systems being controlled and include a written sequence of operation as it appears in these specifications. Any deviation from the written sequences shall be highlighted by the Temperature Controls Contractor (TCC) or Original Equipment Manufacturer (OEM) so that the Designer and the Facilities Management Systems Integrator (FMSI) can review, comment and respond to each change. Omission of a sequence or modification of a sequence does not relieve the TCC or OEM from providing the specified sequence.

PART 2 - PRODUCTS

SEQUENCE OF OPERATION

A. Finned-Tube Radiators

Provide room thermostat to maintain space temperature by controlling the radiator hot water valve. BMS shall employ existing digital control. All space heating controls shall only be enabled during the Winter mode and shall be de-activated during the Summer mode.

VAV Terminal Units with Hot Water Radiators: The tie-in of the control valve to VAV controller shall permit integrated room heating/cooling controller to control by modulating the radiator control valve. In each room the perimeter radiation control valve shall be controlled through the controller (see VAV Box control paragraph below this article for more detail). All space heating controls shall only be enabled during the Winter mode and shall be de-activated during the Summer mode.

1. All finned-tube radiation units shall be provided with electric/electronic control valves as indicated.
2. BMS I/O Points: Provide the BMS I/O points as specified and as shown on the Drawings.

B. Variable Air Volume Box Control (cooling-only) with perimeter heating system

1. System Description: The VAV box damper and perimeter fin tube radiator valve shall be controlled by a dedicated, VAV box DDC controller. Each area served shall have mounted within its space a local zone device which shall provide the space temperature sensor and setpoint adjustment. In addition, non-corridor spaces served by VAV boxes shall be equipped with occupancy sensors that shall reset the occupied minimum ventilation rate to a standby vacant minimum ventilation rate when the space becomes vacant during normal scheduled occupied hours. Each perimeter fin tube radiator shall have a modulating control valve. During the heating mode, the controller shall be polled on 10 minute intervals to provide the hot water valve positions to be used for hot water pump differential pressure reset logic. During the cooling mode, the controller shall be polled on 10 minute intervals to provide the VAV box damper positions to be used for supply fan static pressure reset logic. Controller network polling is not limited to 10 minute intervals. Per Section 6.5.3.2.3 of ASHRAE 90.1-2013, controls shall be able to automatically detect those zones that may be excessively driving the reset logic and generate an alarm to the system operator to allow for operator removal of zone(s) from the reset algorithm.
2. Operating Mode: The operating modes of the VAV box controller shall be sequenced occupied heating and cooling and unoccupied heating and

cooling through a space temperature sensor and space occupancy controller wired to the DDC controller. Occupied and standby vacant modes shall be automatically determined by the occupancy sensor.

- a. Occupied Mode during Scheduled Occupancy Periods: When the occupancy sensor determines that the room is occupied, the active VAV box minimum shall be the occupied minimum air flow setpoint as shown on the Drawings schedule. Once the occupied mode has begun, it shall continue for a minimum of one-half hour after which time it may revert to the standby vacant mode (during scheduled occupancy periods). During the occupied mode, VAV damper shall be commanded to its occupied minimum position during the heating mode and shall modulate as required to meet the space setpoint during the cooling mode.
 - b. Standby Vacant Mode during Scheduled Occupancy Periods: The active VAV box minimum shall be the standby minimum vacant air flow setpoint as shown on the Drawings schedule if the occupancy sensor determines that the classroom is vacant after a 30-minute delay. During the standby mode, VAV damper shall be commanded to its standby minimum position during the heating mode and shall modulate as required to meet the space setpoint during the cooling mode. The VAV box shall be polled on ten minute intervals for indication if the box is in standby or occupied minimum flow to allow the central unit to tally the amount of outside air needed for resetting the central unit outside air flow setpoint.
 - c. Unoccupied Cooling Mode during Scheduled Unoccupied Periods: The VAV box shall be opened to the occupied minimum ventilation rate position as shown on the Drawings schedule. Central air unit shall cycle its supply fan until the representative room has met the unoccupied space setpoint of 85°F.
3. Scheduling: The DDC Scheduler shall place the DDC controlled VAV box in the unoccupied mode or occupied mode.
 4. Scheduled Occupied Cooling Mode: On a drop in space temperature below its occupied cooling setpoint of 78°F nominal adjustable, the VAV box shall modulate from its maximum cooling airflow setting to its minimum occupied cooling airflow setting during occupied hours or to its minimum standby vacant cooling airflow setting during occupied hours. Occupancy or vacancy shall be determined by space occupancy sensor subject to 30-minute time delay, adjustable. On a rise in space temperature the reverse sequence shall occur.
 5. Scheduled Occupied Heating Mode: In heating mode, the VAV box shall maintain its minimum occupied airflow setting during scheduled occupied

hours or its minimum standby airflow setting during scheduled occupied hours. Occupancy or vacancy shall be determined by space occupancy sensor subject to 30-minute time delay, adjustable. On a drop in space temperature below its occupied heating setpoint of 72°F nominal adjustable, the baseboard radiation valve shall be modulated open to maintain its heating setpoint of 72°F. On a rise in space temperature, the reverse sequence shall occur.

6. Scheduled Unoccupied Heating Mode: VAV box shall be commanded closed and VAV controller shall maintain the unoccupied heating setpoint of 55°F by throttling the perimeter unit control valve. During the emergency heating mode should the spaces fall to 50°F and the central air unit energizes, the VAV boxes shall be commanded to their minimum occupied ventilation position.
7. Warm Up Cycle: All VAV boxes shall be opened to their minimum occupied ventilation position in the warm-up cycle. See the sequence of operation for the central air unit. The fin tube radiation shall assist the Air Handling Units during the warm up cycle. The space temperature during the warm up mode shall be adjusted to 72°F and the fin tube radiation valve shall modulate as required to achieve a space temperature of 72°F. Cycle start time shall be based on the difference between the current temperature and the occupied setpoint for optimum start controls. Additionally, per Section 6.4.3.3.3 of ASHRAE 90.1-2013, the control algorithm shall also be a function of the outdoor temperature and the amount of time prior to scheduled occupancy.
8. Pull-Down and Purge Cycle: All VAV boxes shall be opened to their minimum occupied ventilation position. See the applicable sequence of operation for the central air unit.
9. All space heating controls shall only be enabled during the Winter mode and shall be de-activated during the Summer mode. All cooling sequences shall be disabled during the Winter mode and only enabled in the Summer mode.
10. I/O Points: Provide the I/O points as specified.

C. Toilet Exhaust Fan Control:

1. Dedicated exhaust fans utilized for toilet exhaust, locker rooms, storage rooms, etc. shall be monitored and automatically controlled by the BMS system for remote DDC control and status indication. Fractional horsepower motors shall be controlled through local manual switches in a non-automatic mode unless otherwise noted.
2. For all motors provided with ON-OFF-AUTO (H-O-A) combination motor starters, the following control sequence shall be provided:

- a. The fan exhaust systems shall be indexed ON by the DDC Scheduler whenever the building is indexed to the occupied mode of operation. Exhaust fans associated with recirculating systems need not be placed into operation during non-occupied periods since the supply unit shall be operating in a recirculation mode where all outside air intake dampers and spill dampers shall be closed.
 - b. The fan exhaust systems shall be indexed off (as defined above) by the DDC Scheduler whenever the building is indexed to the unoccupied mode of operation.
 - c. Each fan shall be capable of operating under a unique time schedule and controlled from the DDC Scheduler.
 - d. In general, whenever an exhaust fan is indexed to start its respective intake/exhaust damper(s) shall be energized, opening the exhaust damper. Whenever an exhaust fan is indexed to stop its respective intake/exhaust damper(s) shall close. All interlocks to powered damper actuators shall be from combination motor starter.
 - e. Exhaust fan status shall be monitored through motor-leg current switch for fan motor run status when a BMS system is utilized.
3. For exhaust fans not controlled from the DDC Scheduler, provide separate 7-day time clock located where shown on the Drawings or as coordinated with the Authority.

D. VARIABLE VOLUME AIR HANDLING UNIT WITH HOT WATER AND CHILLED WATER COILS, DDC CONTROLS

A. General System Overview

- 1. Safety Devices. Safeties shall be in force at all times and all modes of operation, including all operating modes of the VFDs.
 - a. Supply Duct Overpressure Control: If the static pressure in the supply duct exceeds the positive static pressure switch setpoint for any reason, the supply fan shall stop and AHU shall remain in the System-OFF Mode until the safety pressure switch is manually reset. After the alarm is cleared, the AHU shall resume its normal operation according to the appropriate mode. A change-of-state alarm shall be generated at the SOC/HMI. Note that this fan safety shall be hardwired to shut the fan off in all modes of operation.
 - b. Clogged Filter Alarms: There shall be installed an indicating, differential pressure transducer across outside air filter banks

which shall indicate the combined pressure drop across the filters. A clogged filter alarm shall be generated at the SOC/HMI when the pressure drop exceeds the combined pressure drops as recommended by the filter manufacturer for replacement for each bank of filters.

- c. Freeze Protection Lockout: The freeze protection device shall be wired into the supply fan motor VFD to shutdown the supply fan upon reaching its setpoint. Unit shall be sent to System Off Mode. OEM limit control freezestat with serpentine element located on the inlet of the chilled water cooling coil shall stop all fans to prevent cooling coil freeze-ups and to prevent cold air being distributed to the building thus avoiding potential building pipe freeze-ups. Set at 39°F (adjustable). Freezestat shall reset automatically unless any trip exceeds 30 seconds as measured by the integral timer. Trips exceeding 30 seconds shall require manual reset. At the same time an alarm signal is sent to the DDC controller and an alarm is displayed on the SOC/HMI.
2. Fire Alarm Shut Down: This sequence of operation shall be in force at all times and under all modes of operation.
 - a. The Fire Alarm contractor shall furnish and the mechanical contractor shall install the smoke detector(s) to shut down the system upon sensing smoke. Furthermore, the following shall be provided through electrical division.
 - b. During a fire alarm condition, the Fire Alarm Control Panel (FACP) shall shut down the supply fan and the exhaust fan shall continue to operate when in the 100% outside air mode. Supply fan shall remain in the System-OFF Mode until the alarm condition is cleared. After the fire alarm shutdown is cleared, all smoke and fire/smoke dampers shall be commanded open by the FACP.
 - c. Fire alarm system activation initiated by manual pull station shall not shut down the unit supply and exhaust fans and shall not close the associated smoke and/or fire/smoke damper if in the testing mode.
 - d. Exhaust systems that do not recirculate air shall not be provided with smoke dampers and shall not be shutdown by the fire alarm system. Fire dampers shall be provided as required at penetrations of fire rated construction.
 - e. The Mechanical Contractor shall provide duct Smoke Damper (SD) and Combination Fire/Smoke Dampers (FSD) with actuators and proof-of-open end-switches. The FACP shall monitor all

associated end-switches for proof-of-open on an individual or zone basis. The FACP shall indicate via a FACP mounted LED that a damper or zone of dampers has not proven open. Fire/smoke dampers associated with the post- fire smoke purge system and smoke control systems shall be monitored on an individual basis by the FACP.

3. I/O Points: Provide the I/O points as specified.

B. Operating Modes. The operating modes of the unit shall be automatically determined by the combined actions of the DDC Scheduler, the local unit mounted HAND-OFF-AUTO switch; and the Fire Alarm System electrical division.

1. Mode Selection and Fan Operation:

- a. The operator shall be able to manually select the operating mode through an H-O-A switch (labeled HAND-OFF-AUTO) mounted in the unit and wired into the digital controller. In the automatic-position the unit is indexed automatically by the DDC Scheduler between the various modes of operation described herein. In the HAND position the unit shall remain in the Occupied Mode. In the OFF position the unit shall remain off. Note that the H-O-A switch is not the same as the manufacturer's service switch which shall shutdown the unit.
- b. When the H-O-A switch is placed into either the "HAND" or the "OFF" position an advisory is generated at the SOC/HMI.
- c. Unit's fans shall be commanded to start by the DDC Scheduler.
- d. Fan Acceleration/De-acceleration: When the supply fan is started, the fan shall be slowly accelerated up to the required speed according to the ramp adjustments in the VFD. The ramp-up time shall be set to (30) seconds. When the fan is de-energized it shall be de-energized immediately without de-acceleration.
- e. Summer/Winter Mode Selection: The unit shall be automatically indexed to operate in either the Summer Mode or Winter Mode based on the outside ambient temperature or manually indexed.
 - 1) Winter Mode: If the outside temperature is less than or equal to 50°F, the unit shall be indexed to the Winter Heating Mode.

- 2) If the outside temperature is greater than 50°F but less than 55°F, the unit shall be in whatever Mode was the last Mode of operation (heating or cooling).
- 3) Summer Mode: If the outside temperature is greater than or equal to 52°F but less than 65°F and the outside air enthalpy is less than the return enthalpy, the unit shall be indexed to the Summer Economizer Cooling Mode. If the outside temperature is greater than or equal to 55°F but less than 65°F and the outside air enthalpy is greater than the return enthalpy, the air handling unit shall be indexed to Summer Mechanical Cooling Mode. If the outside temperature is greater than or equal to 65°F, the unit shall be indexed to the Mechanical Cooling Mode.
- 4) Economizer Mode: If the return air exceeds 78°F for a time delay of 30 minutes (adjustable), the unit shall be indexed to Summer Mechanical Cooling Mode
- 5) The system shall have the ability to do a manual Summer/Winter changeover by selection at the Building Operating Console (BOC). A network variable input shall be able to be sent to the Unit controller to override the applicable automatically calculated HVAC mode.

f. Supply Fan Control:

- 1) The supply fan shall be started and stopped as described in these sequences.
- 2) During the heating and cooling occupied cycles, the supply fan VFD speed shall remain under the control of the duct static pressure controller to maintain its setpoint. The final setpoint setting shall be determined by the Testing & Balancing Contractor and shall be subject to critical zone reset. During the occupied cycles, the outside air damper shall be placed under the control of the outside air intake air flow measuring station to provide the cumulative instantaneous minimum code required ventilation air.
- 3) Upon proof of supply fan operation, in all modes of fan operation, the control sequence shall proceed according to the appropriate Mode. If the supply fan does not prove ON, a SOC/HMI alarm shall be issued.

g. Supply Duct Static Pressure Setpoint Control:

During the occupied cycles, the supply fan VFD shall slowly ramp up to the initial setpoint of 1.2" WC total design fan static pressure as sensed by the supply duct static pressure sensor. In cooling, static pressure setpoint shall be reset upwards or downwards from the initial 1.2" WC setpoint based on the zone requiring the most pressure; i.e. the setpoint is reset until one zone damper is nearly wide open (greater than 85% open and less than 95% open). During all occupied cycles, each unit controller shall be networked with all associated VAV terminal units to obtain VAV box damper positions and to broadcast the vacant standby or occupied minimum flow setpoints on ten-minute polling intervals so the central unit controller can tally up and compute the required cumulative instantaneous minimum outside air flow required at the central unit outside air intake port. In cooling, the static pressure setpoint shall be reset based on zone airflow requests derived from VAV box damper positions or other indicator of need for static pressure and shall meet the airflow and space temperature requirements. In cooling, when all VAV box zone dampers are throttling closed - below 85% open, the VAV supply fan duct static pressure setpoint shall be incrementally adjusted by 0.10" WC steps at a frequency of 10 minutes until the supply fan VFD has reached its lowest operating speed limit (based on being 5% above stall speed and to avoid excessive motor temperature, set by balancer or limiting system characteristics such as minimum heating or cooling system flows, instrument flow measuring minimum stable flow, etc.) until the most Critical VAV Box Zone (CZ) is above 85% open. In cooling, when the CZ is greater than 95% open and cooling requests (space temperatures) are not satisfied, the reverse shall occur. If the measured duct static pressure is less than the duct static pressure setpoint, the fan speed shall be increased. If the measured duct static pressure is greater than the duct static pressure setpoint, the fan speed shall be decreased. Per Section 6.5.3.2.3 of ASHRAE 90.1-2013, controls shall be able to automatically detect those zones that may be excessively driving the reset logic and generate an alarm to the system operator to allow for operator removal of zone(s) from the reset algorithm. Critical Zone Reset Logic is not performed in Winter Mode as all boxes are sent to minimum flow position in occupied mode.

2. System-OFF Mode:

- a. The unit supply fan shall be OFF; the unit dampers shall be commanded to their respective fail-safe positions as follows: outside air and exhaust air dampers closed, recirculation air damper open; cooling and hot water valves closed.

3. Unoccupied Mode:
 - a. Winter Mode: The unit shall be in the System-OFF mode and the perimeter system shall maintain the spaces at 55°F.
 - b. Unoccupied Summer Cooling Mode: The unit shall be cycled to maintain a cooling mode night set up space temperature high-limit (HHL) setpoint as described below. Where the chiller is shut down during the unoccupied Summer Mode period, the DDC controller shall send an Occupied Command over the network to the chilled water system to become enabled during the active Unoccupied Cooling Mode when the north facing room space temperature rises above the HHL setpoint of 85°F.
 - 1) When the north facing room space temperature rises above the HHL setpoint of 85°F, then the supply fan shall be started under static pressure setpoint control; the dampers shall be in the full-recirculation position as follows: the recirculation damper fully opened and the outside air and exhaust dampers closed. During the unoccupied cooling mode, the VAV boxes shall be commanded to their minimum occupied ventilation position.
 - 2) Upon proof of air flow, cooling valve shall be modulated to maintain a cooling coil discharge temperature of 52°F.
 - 3) After the space temperature falls below the HHL setpoint, less a differential of 2°F, cooling valve shall be modulated closed. The supply fan shall be de-energized and the unit shall cycle OFF. Should the space temperature rise again during the unoccupied cooling mode time period, the cycle shall repeat.
4. Morning Warm-up: The unit shall be in the System-OFF mode and the perimeter system shall bring the spaces to 72°F.
5. Morning Purge: Pre-occupancy space cooling shall be required as sensed by the combination space temperature and humidity sensor before the system is indexed from the unoccupied to the occupied mode.
 - a. Pre-Occupied Morning Purge Cycle:
 - 1) The DDC Controller shall calculate space enthalpy from the combination of the space temperature and space relative humidity sensor readings to the broadcast value of the calculated outside air enthalpy. If the outside air enthalpy is less than the inside enthalpy, a pre-occupied morning purge cycle shall be initiated for a (15) minute duration.

- 2) During the pre-occupied morning purge cycle, 100% outside air shall be introduced into the building to purge the building air before occupancy. The outside air and exhaust air dampers are to be indexed to their fully open positions and the recirculation air damper to the fully closed position. During the pre-occupied morning purge mode, the VAV boxes shall be commanded to their minimum occupied ventilation position.
- 3) The central unit supply fan shall be indexed to static pressure setpoint control with mechanical cooling locked out until the morning purge cycle is terminated. The pre-occupied morning purge cycle shall be terminated after a 15-minute cycle. The pre-occupied morning purge cycle, if initiated, shall be followed by a pre-occupied pull-down cycle.

b. Pre-Occupied Pull-down Cycle:

- 1) After the purge cycle (or if the space temperature exceeds the space temperature setpoint of 78°F plus 0 minus 2°F nominal adjustable), a pull down cycle shall be initiated where the outside air and exhaust air dampers are fully closed and the recirculation damper is fully opened. During the pull down mode, the VAV boxes shall be commanded to their minimum occupied ventilation positions. Cycle start time shall be based on the difference between the current return air temperature and occupied temperature setpoint for optimum start controls. Additionally, per Section 6.4.3.3.3 of ASHRAE 90.1-2013, the control algorithm shall also be a function of the outdoor temperature and the amount of time prior to scheduled occupancy. During the pull down cycle, the unit chilled water valve shall modulate to provide a maximum cooling coil discharge temperature of 52°F. The pull down cycle shall continue until the return air temperature is less than or equal to 78°F plus 0 minus 2°F at which time the chilled water valve shall close and the fans shall de-energize. Should the space temperature rise again during the pull down cycle time period, the cycle shall repeat. The pull down cycle shall terminate when the unit is indexed into Occupied Mode.
- 2) Once the pre-occupied pull-down cycle is terminated by the system being indexed into Occupied Mode, the unit shall be indexed to occupied economizer cooling or occupied mechanical cooling.

6. Occupied Mode: When the unit is indexed to the occupied mode, the following occurs.
 - a. The supply fan shall be started and the supply fan VFD speed shall be placed under control of the duct static pressure controller to maintain its setpoint.
 - b. Upon proof of supply fan operation, the control sequence shall operate in the occupied mode. Morning Warm-up or Morning Purge/Pull Down shall not be active when in the occupied mode. If the fans do not prove ON, an alarm shall be issued to the SOC/HMI.
 - c. When indexed to occupied heating mode, the recirculation damper shall be modulated to provide the supply fan flow to meet the static pressure setpoint when the outside air flow rate is reduced due to the cumulative outside air value being lowered from the occupancy flow rate due to rooms in standby flow condition. The outside air damper shall be fully opened and the supply fan speed shall be modulated to provide the static pressure setpoint. The outside air flow monitoring station shall measure the outside air flow and provide the flow signal to the controller which in turn shall modulate the outside air modulating damper. The exhaust damper shall open and the exhaust air flow monitoring station shall provide the required flow signal (supply air flow less 10%) to the controller. The chilled water valve shall be closed and the hot water valve shall be modulated to provide a nominal 65°F (adjustable) discharge air temperature. The perimeter system units shall be modulated to provide a nominal 72°F (adjustable) space temperature in each of the spaces.
 - d. During occupied Economizer Cooling Mode when the mechanical cooling valve is closed, the unit shall attempt to maintain a maximum supply duct dry-bulb temperature of 52°F as sensed by the supply duct temperature sensor. For the Economizer Cooling Mode, the outside air temperature shall be greater than or equal to 52°F but less than 65°F. The actual supplied air temperature to the spaces shall be greater than or equal to 52°F but less than 65°F. The unit operates in a 100% outside air mode with outside air and exhaust air dampers fully open and recirculation dampers fully closed.

On a rise in return duct temperature above 78.0°F for a time delay of 30 minutes (adjustable), the Economizer Cooling Mode shall be deemed inadequate to meet the maximum acceptable conditions at which time the unit shall be commanded to the occupied

Mechanical Cooling Mode, the outside air and recirculated air dampers are indexed back to occupied air flow settings.

During the mechanical cooling occupied period return air relative humidity is indirectly controlled for dehumidification by maintaining the discharge air off the chilled water cooling coils at 52°F maximum which should always keep the space within the comfort zone as defined in ASHRAE 55-2010. The outside air dampers shall be modulated to provide the cumulative instantaneous minimum ventilation flow as measured by the outside air flow meter. The exhaust damper shall be modulating to provide the proper pressurization with the exhaust flow equaling 85% to 90% of the cumulative instantaneous outside air flow. Mechanical chilled water valve shall be modulated to maintain a maximum 52°F cooling coil discharge temperature to maintain a return air temperature setpoint between 76°F and 78°F. If return air temp drops below 75°F, the chilled water valve shall be modulated to provide the required cooling coil discharge air temperature to maintain a return air temperature setpoint between 76°F and 78°F. The chilled water coil discharge temperature shall return to 52°F when the return air temperature rises to 78°F.

7. Return Air Reset of Supply Air Temperature:
 - a. After the warm-up mode is completed in winter mode, the supply air temperature of the unit shall be controlled to maintain a minimum supply air temperature setpoint (reset from return air temperature) of 60°F to 65°F (adjustable).
 - b. After the pre-purge and pull down modes are completed in the summer mode; the coil air temperature of the unit shall be controlled to maintain a coil air temperature setpoint of 52°F.
8. Communication:
 - a. Upon loss of communication with the network, the unit DDC controller shall operate in the applicable seasonal occupied mode as determined by the outside air temperature (before the loss of communication).

PART 3 – CRAC UNITS CONTROL SEQUENCES

3.1 SYSTEM START DELAY

- A. After the self-test is complete, the Timed Start Delay will be displayed and will start counting down from the programmed delay time. The factory setting is five (5) seconds. The setting is programmed in Menu A – ON/OFF. The range is from 1 to 600 seconds in 5 second increments.

3.2 BLOWER

- A. Plug Fans – Units with plug fans have a “soft-start”.

3.3 FUNCTIONS

- A. Cooling, reheat, and humidification functions are inhibited for one (1) minute after the blower starts. This allows the temperature and humidity sensors to adjust.

3.4 COMPRESSOR COOLING

- A. There is a five (5) minute delay between start-to-start of the same primary stage compressor. The delay will be increased to six (6) minutes for one (1) hour following the detection of a compressor short-cycle condition even if the compressor short cycle alarm is disabled.

- B. Compressor staging sequence at each adjustment period:

- a. Compressor “ON” sequence (Increasing Temperature)
- b. Cool 1 ON at Temperature Setpoint + Temperature Deadband
- c. Cool 2 ON at Temperature Setpoint + Temperature Deadband + $y^{\circ}\text{F}$
Compressor “OFF” sequence (Decreasing Temperature)
- d. Cool 2 OFF at Temperature Setpoint + $y^{\circ}\text{F}$ Cool 1 OFF at Temperature Setpoint

Note: y = “stage to stage” which can be changed in MenuB-Setpoints; default value is 0.3

- C. If the temperature drops below the setpoint during an adjustment period, all compressors turn OFF at once.

3.5 ELECTRIC REHEAT LOGIC

- A. ELECTRIC

The reheat only allows coming on during the dehumidification cooling cycle. When reheat comes on, it will try to satisfy the unit temperature setpoint. If the humidity setpoint satisfies and the dehumidification cooling stops, the reheat will be disable as well.

3.6 HUMIDIFICATION

- A. Humidification will inhibit the reheat if programmed (See Menu J Factory Settings) for Humidifier: Computer Non-Modulating or Humidifier: Computer Modulating. Reheat is allowed during humidification if programmed for Humidifier Comfort, Non-Modulating or Humidifier Comfort, Modulating.
- B. There is a one (1) minute delay between the stop-to-start of humidification.
- C. There is a five (5) minute delay between the dehumidification and start of humidification.
- D. The humidification staging sequence of each adjustment period for ON/OFF of non-modulating humidifiers is as follows:
 - Humidifier is ON at Humidity Setpoint – Humidity Deadband
 - Humidifier is OFF at Humidity Setpoint – 1.0%
- E. The humidification staging sequence for a modulating humidifier is as follows:
 - Valve is OPENED at Humidity Setpoint – 1.0%
 - Valve is CLOSED at Humidity Setpoint – 0.5%
- F. When the humidifier valve is opened, its position will follow a linear ramp that goes from 25% open with the humidity at setpoint minus 0.5% to 100% open at setpoint minus humidity deadband.
- G. Humidifier Operation
 - a. Humidifier will turn on when dewpoint is below Low Dewpoint Setpoint
 - b. Humidifier will turn off when dewpoint is above Low Dewpoint Setpoint + Low Dewpoint Deadband
 - c. If Low Dewpoint Setpoint is set too high, the humidifier might run pass the relative humidity setpoint. When this happens, the humidifier will be inhibited and a warning will display on dap4 LCD screen

END OF SECTION 230994

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Joining materials.
4. Transition fittings.
5. Dielectric fittings.

1.2 ACTION SUBMITTALS

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of the following:

1. Pipe.
2. Fittings.
3. Joining materials.

C. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components indicating coordination with general construction, building components, mechanical systems, and other building services.
2. Structural members to which elements of construction will be attached.

3. Size and location of initial access modules for acoustical panels.
4. Size and location of items penetrating finished ceilings including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings
5. Ducts associated with HVAC systems.
6. Penetrations of smoke barriers and fire-rated construction.
7. Piping associated with HVAC, plumbing, and fire protection systems.
8. Electrical conduits and cable trays.

The Contractor and each Installer shall approve (sign-off on) the Coordination Drawings prior to their submission.

B. Quality Assurance Submittals:

1. Manufacturer Certification Letter for gaskets in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. Qualification Data: For Installer.

D. Welding certificates.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

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

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Hot-Water Heating Piping: 100 psig at 200 deg F.
 - 2. Chilled-Water Piping: 150 psig at 73 deg F.
 - 3. Condensate-Drain Piping: 150 deg F.
 - 4. Air-Vent Piping: 180 deg F.
 - 5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.
 - 1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
 - 2. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
- E. Copper or Bronze Pressure-Seal Fittings:
 - 1. Housing: Copper.
 - 2. O-Rings and Pipe Stops: EPDM.
 - 3. Tools: Manufacturer's special tools.
 - 4. Minimum 200-psig working-pressure rating at 250 deg F.
- F. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.
- G. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications."
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications."
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications."
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications."
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- H. Grooved Mechanical-Joint Fittings and Couplings:
 - 1. From the selection please select three (3) manufacturers.
 - 2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 - 3. Couplings: Ductile- or malleable-iron housing and EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- I. Steel Pressure-Seal Fittings:
 - 1. Housing: Steel.
 - 2. O-Rings and Pipe Stop: EPDM.
 - 3. Tools: Manufacturer's special tool.
 - 4. Minimum 300-psig working-pressure rating at 230 deg F.
- J. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 125 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Description:
 - a. Standard: ASSE 1079.
 - b. Factory-fabricated, bolted, companion-flange assembly.
 - c. Pressure Rating: [125 psig minimum at 180 deg F.

- d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:

- a. Nonconducting materials for field assembly of companion flanges.
- b. Pressure Rating: 150 psig.
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Description:

- a. Standard: IAPMO PS 66.
- b. Electroplated steel nipple, complying with ASTM F 1545.
- c. Pressure Rating: 300 psig at 225 deg F.
- d. End Connections: Male threaded or grooved.
- e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:

- 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- 2. Schedule 40, Grade B, Type 96 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
- 3. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

- 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 2. Schedule 40 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.
 3. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.
 4. Schedule 40 CPVC plastic pipe and fittings and solvent-welded joints.
- D. Chilled-water piping, aboveground, NPS 2-1/2, shall be any of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and [soldered] [brazed] joints.
 2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
 3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.
- E. Condensate-Drain Piping: Type M, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- F. Air-Vent Piping:
1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- G. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

- A. Plans indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.

- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install shutoff valve immediately upstream of each dielectric fitting.
- S. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
 - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 7 feet.
 - 2. NPS 1: Maximum span, 7 feet.
 - 3. NPS 1-1/2: Maximum span, 9 feet.
 - 4. NPS 2: Maximum span, 10 feet.
 - 5. NPS 2-1/2: Maximum span, 11 feet.
 - 6. NPS 3 and Larger: Maximum span, 12 feet.

- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

- I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- J. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 - 3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY:

A. Section includes special-duty valves and specialties for the following:

1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.
4. Connectors.

1.2 ACTION SUBMITTALS:

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of the following:

1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Hydronic Specialty Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
4. Air-control devices.
5. Strainers.
6. Connectors.

1.3 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE:

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS:

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.

F. Diaphragm-Operated Safety Valves: ASME labeled.

1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Wetted, Internal Work Parts: Brass and rubber.
7. Inlet Strainer: , removable without system shutdown.
8. Valve Seat and Stem: Noncorrosive.
9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Body: Brass or ferrous metal.
2. Piston and Spring Assembly: Corrosion resistant, tamper proof, self-cleaning, and removable.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
7. Minimum CWP Rating: 175 psig.
8. Maximum Operating Temperature: 200 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.

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.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shut-off duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install throttling-duty valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Install 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.

END OF SECTION 232116

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Refrigerant pipes and fittings.
2. Refrigerant piping valves and specialties.
3. Refrigerants.

1.2 ACTION SUBMITTALS

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. 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. Thermostatic expansion valves.
 - b. Solenoid valves.
 - c. Hot-gas bypass valves.
 - d. Filter dryers.
 - e. Strainers.
 - f. Pressure-regulating valves.

C. Shop Drawings:

1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
2. 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.
3. Show interface and spatial relationships between piping and equipment.
4. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components indicating coordination with general construction, building components, mechanical systems, and other building services.
 2. Structural members to which elements of construction will be attached.
 3. Size and location of initial access modules for acoustical panels.
 4. Size and location of items penetrating finished ceilings including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings
 5. Ducts associated with HVAC systems.
 6. Penetrations of smoke barriers and fire-rated construction.
 7. Piping associated with HVAC, plumbing, and fire protection systems.
 8. Electrical conduits and cable trays.
- The Contractor and each Installer shall approve (sign-off on) the Coordination Drawings prior to their submission.
- B. Welding certificates.
- C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.5 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."

1.6 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-410A:
 - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
 - 2. Suction Lines for Heat-Pump Applications: 535 psig.
 - 3. Hot-Gas and Liquid Lines: 535 psig.

2.2 COPPER TUBE AND FITTINGS

- A. Copper Tube: L.
- 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 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. Body and Bonnet: Forged brass or cast bronze.
2. Packing: Molded stem, back seating, and replaceable under pressure.
3. Operator: Rising stem.
4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
5. Seal Cap: Forged-brass or valox hex cap.
6. End Connections: Socket, union, threaded, or flanged.
7. Working Pressure Rating: 500 psig.
8. 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 psig.
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-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. End Connections: Socket, flare, or threaded union.
 8. 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-V ac coil.
 8. End Connections: Socket.
 9. Throttling Range: Maximum 5 psig.
 10. Working Pressure Rating: 500 psig.
 11. 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.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with AHRI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 240 deg F.

N. Mufflers:

1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.

4. Maximum Operating Temperature: 275 deg F.
- O. 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.
 7. Maximum Operating Temperature: 275 deg F.
- P. Liquid Accumulators: Comply with AHRI 495.
1. Body: Welded steel with corrosion-resistant coating.
 2. End Connections: Socket or threaded.
 3. Working Pressure Rating: 500 psig.
 4. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

- A. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 3-1/2 and Smaller NPS 2 to NPS 3-1/2 for Conventional Air-Conditioning Applications: Copper Type L, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type L, drawn-temper tubing and wrought-copper fittings with soldered joints.
- D. Hot-Gas and Liquid Lines: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- E. Hot-Gas and Liquid Lines: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

- F. Hot-Gas and Liquid Lines: Copper Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- G. Hot-Gas and Liquid Lines Type L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- H. Hot-Gas and Liquid Lines NPS 2 to NPS 4: Schedule 40, black-steel and wrought-steel fittings with welded joints.
- I. Safety-Relief-Valve Discharge Piping: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- J. Safety-Relief-Valve Discharge Piping: Copper, Type K, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- K. Safety-Relief-Valve Discharge Piping: Copper, Type L, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- L. Safety-Relief-Valve Discharge Piping: Copper, Type L, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- M. Safety-Relief-Valve Discharge Piping:
 - 1. NPS 5/8 and Smaller: Copper, Type L, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- N. Safety-Relief-Valve Discharge Piping NPS 2 to NPS 4: Schedule 40, black-steel and wrought-steel fittings with welded joints.

3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. 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.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.
- E. Install a full-size, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. 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.
- H. 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.
- I. 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.
- J. 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.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.

3.3 PIPING INSTALLATION

- A. 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.
- 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. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install refrigerant piping in protective conduit where installed belowground.
- L. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- M. 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.
- N. 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.
- O. 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.
- P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

- Q. Identify refrigerant piping and valves according to Section 230553 "Identification for HVAC Piping and Equipment."
- R. 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."
- S. 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."
- T. 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. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. 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.
- F. 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.
- G. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.

- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12.
- I. 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 run 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: Maximum span, 60 inches; minimum rod, 1/4 inch.
 - 2. NPS 5/8: Maximum span, 60 inches; minimum rod, 1/4 inch.
 - 3. NPS 1: Maximum span, 72 inches; minimum rod, 1/4 inch.
 - 4. NPS 1-1/4: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 5. NPS 1-1/2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 6. NPS 2: Maximum span, 96 inches; minimum rod, 3/8 inch.
 - 7. NPS 2-1/2: Maximum span, 108 inches; minimum rod, 3/8 inch.
 - 8. NPS 3: Maximum span, 10 feet; minimum rod, 3/8 inch.
 - 9. NPS 4: Maximum span, 12 feet; minimum rod, 1/2 inch.
- D. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 2: Maximum span, 10 feet; minimum rod, 3/8 inch.
 - 2. NPS 2-1/2: Maximum span, 11 feet; minimum rod, 3/8 inch.
 - 3. NPS 3: Maximum span, 12 feet; minimum rod, 3/8 inch.
 - 4. NPS 4: Maximum span, 14 feet; minimum rod, 1/2 inch.
- 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. 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.
 - 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 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Sheet metal materials.
3. Sealants and gaskets.
4. Hangers and supports.
5. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 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 and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.3 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For each type of the following products:

1. Sealants and gaskets.

2. Seismic-restraint devices.

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. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

D. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components indicating coordination with general construction, building components, mechanical systems, and other building services.
2. Structural members to which elements of construction will be attached.
3. Size and location of initial access modules for acoustical panels.
4. Size and location of items penetrating finished ceilings including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings
5. Ducts associated with HVAC systems.

6. Penetrations of smoke barriers and fire-rated construction.
7. Piping associated with HVAC, plumbing, and fire protection systems.
8. Electrical conduits and cable trays.

The Contractor and each Installer shall approve (sign-off on) the Coordination Drawings prior to their submission.

B. Quality Assurance Submittals:

1. Manufacturer Certification Letter for sealants in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, 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: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. 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.
- 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. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. 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.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

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.

2.5 SEISMIC-RESTRAINT DEVICES

- A. Approved Manufacturers:
 - 1. Mason Industries, INC.
 - 2. Vibration Eliminator Co.
 - 3. Korfund Dynamics Co.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 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.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

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 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. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. 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 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts at a minimum 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. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
 - 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
 - 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 - 12. Conditioned Space, Return-Air Ducts: Seal Class C.

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.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "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 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 2. Test the following systems:
 - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - b. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, selected by Architect from sections installed, totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - d. Exhaust Ducts with a Pressure Class of 2-Inch
 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 4. Test for leaks before applying external insulation.

5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Terminal Units:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
2. Ducts Connected to Variable-Air-Volume Air-Handling Units <Insert equipment>:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 3.
3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 3.

C. Return Ducts:

1. Ducts Connected to Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 2. Ducts Connected to Air-Handling Units
 - a. Pressure Class: Positive or negative 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 6.
- D. 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.
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 3-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 12.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 6.
- F. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel.
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Galvanized.
- G. 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."
- H. 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 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Manual volume dampers.
 2. Control dampers.
 3. Fire dampers.
 4. Flange connectors.
 5. Duct silencers.
 6. Turning vanes.
 7. Duct-mounted access doors.
 8. Flexible connectors.
 9. Duct accessory hardware.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components indicating coordination with general construction, building components, mechanical systems, and other building services.
2. Structural members to which elements of construction will be attached.
3. Size and location of initial access modules for acoustical panels.
4. Size and location of items penetrating finished ceilings including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings
5. Ducts associated with HVAC systems.
6. Penetrations of smoke barriers and fire-rated construction.
7. Piping associated with HVAC, plumbing, and fire protection systems.
8. Electrical conduits and cable trays.

The Contractor and each Installer shall approve (sign-off on) the Coordination Drawings prior to their submission.

B. Quality Assurance Submittals:

1. Manufacturer Certification Letter for flexible connections and ducts in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

C. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.5 SPARE PARTS

A. Furnish spare parts to the Engineer that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. 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 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Available Manufacturers:
 - a. PRICE
 - b. NAILOR
 - c. RUSKIN
 - d. Approved Equal
 - 2. Standard leakage rating, with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Frame: Hat-shaped, 0.094-inch thick, galvanized sheet steel.

- b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 0.064 inch thick.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Tie Bars and Brackets: Galvanized steel.
- B. Standard, Aluminum, Manual Volume Dampers:
- 1. Available Manufacturers:
 - a. AIR BALANCE INC.
 - b. NAILOR
 - c. RUSKIN
 - d. Approved Equal
 - 2. Standard leakage rating with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Tie Bars and Brackets: Aluminum.
- C. Low-Leakage, Steel, Manual Volume Dampers:

1. Available Manufacturers:
 - a. AIR BALANCE INC.
 - b. NAILOR
 - c. RUSKIN
 - d. Approved Equal
2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating[, with linkage outside airstream,] and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
 - a. Hat shaped.
 - b. 0.094-inch- thick, galvanized sheet steel.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel, 0.064 inch thick.
7. Blade Axles: Galvanized steel.
8. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered Aluminum.
11. Tie Bars and Brackets: Aluminum.
12. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

D. Low-Leakage, Aluminum, Manual Volume Dampers:

1. Available Manufacturers:
 - a. AIR BALANCE INC.
 - b. NAILOR
 - c. RUSKIN
 - d. Approved Equal
2. Comply with AMCA 500-D testing for damper rating.

3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
 - d. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
7. Blade Axles: Galvanized steel.
8. Bearings:
 - a. Oil-impregnated bronze.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered Aluminum.
11. Tie Bars and Brackets: Aluminum.
12. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

E. Jackshaft:

1. Size: 0.5-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.4 CONTROL DAMPERS

A. Available Manufacturers:

1. AIR BALANCE, INC
2. NAILOR
3. RUSKIN
4. Approved Equal

- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
 - 1. Hat shaped.
 - 2. 0.094-inch-thick, galvanized sheet steel.
 - 3. Mitered and welded corners.
- D. Blades:
 - 1. Multiple blade with maximum blade width of 6 inches.
 - 2. Opposed-blade design.
 - 3. Galvanized-steel.
 - 4. 0.064 inch thick single skin.
 - 5. Blade Edging: Closed-cell neoprene.
 - 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
 - 1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
 - 1. Oil-impregnated bronze.
 - 2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 3. Thrust bearings at each end of every blade.

2.5 FIRE DAMPERS

- A. Available Manufacturers:
 - 1. AIR BALANCE, INC
 - 2. NAILOR
 - 3. RUSKIN
 - 4. Approved Equal
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Curtain type with blades inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: 0.05 thick, as indicated, and of length to suit application.

2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.024-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

K. Heat-Responsive Device: Electric, replaceable link and switch package, factory installed, 165 deg F rated.

2.6 FLANGE CONNECTORS

A. Available Manufacturers:

1. AIR BALANCE, INC
2. NAILOR
3. RUSKIN
4. Approved Equal

B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.7 DUCT SILENCERS

A. Available Manufacturers:

1. AIR BALANCE, INC
2. NAILOR
3. RUSKIN
4. Approved Equal

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

- C. Shape:
 1. Rectangular straight with splitters or baffles.
 2. Round straight with center bodies or pods.
 3. Rectangular elbow with splitters or baffles.
 4. Round elbow with center bodies or pods.
 5. Rectangular transitional with splitters or baffles.

- D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, 0.034 inch thick.

- E. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
 1. Joints: continuously welded.
 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 3. Reinforcement: Cross or trapeze angles for rigid suspension.

- F. Accessories:
 1. Factory-installed end caps to prevent contamination during shipping.
 2. Removable splitters.
 3. Airflow measuring devices.

- G. Source Quality Control: Test according to ASTM E 477.
 1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
 2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.8 TURNING VANES

- A. Available Manufacturers:
 1. AIR BALANCE, INC
 2. NAILOR
 3. RUSKIN
 4. Approved Equal

- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vaness and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: Single wall.
- F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.9 DUCT-MOUNTED ACCESS DOORS

A. Available Manufacturers:

- 1. AIR BALANCE, INC
- 2. NAILOR
- 3. RUSKIN
- 4. Approved Equal

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

- 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
- 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
- 3. Number of Hinges and Locks:
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges Continuous and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges Continuous and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches: Four hinges Continuous and two compression latches with outside and inside handles.

2.10 DUCT ACCESS PANEL ASSEMBLIES

A. Available Manufacturers:

- 1. AIR BALANCE, INC
- 2. NAILOR
- 3. RUSKIN
- 4. Approved Equal

- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.
- D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.11 FLEXIBLE CONNECTORS

- A. Available Manufacturers:
 - 1. AIR BALANCE, INC
 - 2. NAILOR
 - 3. RUSKIN
 - 4. Approved Equal
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - 1. Minimum Weight: 26 oz./sq. yd.
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - 1. Minimum Weight: 24 oz./sq. yd.
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - 1. Minimum Weight: 16 oz./sq. yd.
 - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
 - 3. Service Temperature: Minus 67 to plus 500 deg F.
- H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 - 1. Minimum Weight: 14 oz./sq. yd.

2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
 3. Service Temperature: Minus 67 to plus 500 deg F.
- I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor 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. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.12 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Compliance with ASHRAE/IESNA 90.1-2004 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," restricts the use of backdraft dampers, and requires control dampers for certain applications. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers according to UL listing.
- H. Connect ducts to duct silencers with flexible duct connectors.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. On both sides of duct coils.
 2. Upstream and downstream from duct filters.
 3. At outdoor-air intakes and mixed-air plenums.
 4. At drain pans and seals.
 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 7. At each change in direction and at maximum 50-foot spacing.
 8. Upstream and downstream from turning vanes.
 9. Upstream or downstream from duct silencers.
 10. Control devices requiring inspection.
 11. Elsewhere as indicated.
- J. Install access doors with swing against duct static pressure.
- K. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
 2. Two-Hand Access: 12 by 6 inches.
 3. Head and Hand Access: 18 by 10 inches.
 4. Head and Shoulders Access: 21 by 14 inches.
 5. Body Access: 25 by 14 inches.
 6. Body plus Ladder Access: 25 by 17 inches.
- L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- M. Install flexible connectors to connect ducts to equipment.
- N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

- P. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- Q. Connect flexible ducts to metal ducts with liquid adhesive plus tape.
- R. Install duct test holes where required for testing and balancing purposes.
- S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Centrifugal In-Line Fan.

1.2 PERFORMANCE REQUIREMENTS:

- ##### A. Operating Limits: Classify according to AMCA 99.

1.3 ACTION SUBMITTALS:

- ##### A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- ##### B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Spring Isolators
7. Fan speed controllers.
8. Spare Parts: Include name, address, and telephone number of in-state supplier of spare parts. No out-of-state suppliers shall be permitted.

- ##### C. 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.

- ##### D. Delegated-Design Submittal: For unit hangers and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. 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.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS:

A. Quality Assurance Submittals:

1. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS:

- A. Maintenance Data: For power ventilators to include in operation, and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 SPARE PARTS:

- A. Furnish to the Engineer spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Belts: One set for each belt-driven unit.

1.7 QUALITY ASSURANCE:

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standards: Power ventilators shall comply with UL 705.

1.8 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver fans as a factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

- B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.

1.9 COORDINATION:

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of equipment supports with actual equipment provided.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL ROOF VENTILATORS:

- 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. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. Acme Engineering & Manufacturing Corporation.
- B. Description: Direct centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly and accessories.
- C. Housing: Split, Spun aluminum with aluminum straightening vanes, inlet & outlet, flanges and support brackets for ceiling mounting.
- D. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- E. Accessories:
 - 1. Variable Speed Controller: Solid State control to reduce speed from 10% to 50%.
 - 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 - 3. Companion Flanges: For inlet & outlet duct connections.

2.2 SOURCE QUALITY CONTROL:

- A. Comply with 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. Comply with 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. Install power ventilators level and plumb.
- B. Support suspended units from structure using threaded steel rods and elastomeric hangers, spring hangers, or spring hangers with vertical-limit stops. Vibration-control devices are specified in CSI Division 23 Section 230548, "Vibration and Seismic Controls for HVAC."
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in CSI Division 23 Section 230553 "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS:

- A. Duct installation and connection requirements are specified in other CSI Division 23 Sections. Plans indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in CSI Division 23 Section 233300, "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to CSI Division 26 Section 260526, "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to CSI Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables."
- E. BAS/ATC control wiring and interlock wiring are specified in CSI Division 23 Section 230900, "Instrumentation and Control for HVAC."

3.3 FIELD QUALITY CONTROL:

- A. Engage a factory authorized service representative to perform the following field tests and inspections and prepare test reports:
 - 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. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 10. Shut unit down and reconnect automatic temperature-control operators.
 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING:

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Comply with requirements in CSI Division 23 Section 230593, "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

3.5 TRAINING:

- A. Refer to From 817 Article 1.20-1.08.14 subsection 3 for additional information.
- B. Engage a factory-authorized service representative to train the Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Fixed face grilles.

B. Related CSI Sections:

1. Division 08 Section 089000, "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section 233300, "Air Duct Accessories" for fire dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 ACTION SUBMITTALS:

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACOR – SUBMITTALS.

B. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.3 INFORMATIONAL SUBMITTALS:

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings
5. Duct access panels.
6. Coordinate installation with Armstrong Techzone Ceiling System.

- B. Quality Assurance Submittals:
 - 1. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS:

A. Rectangular and Square Ceiling Diffusers (D):

- 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. Anemostat Products; a Mestek company.
 - b. Carnes.
 - c. Titus, Model No. TDC-AG-95-AA.
- 2. Devices shall be specifically designed for variable-air-volume flows.
- 3. Material: Aluminum.
- 4. Finish: Baked enamel, white.
- 5. Face Size: As indicated on the Plans.
- 6. Face Style: Four cone minimum.
- 7. Mounting: T-bar.
- 8. Pattern: Fixed (FX), 2 way (2-W), or 4 way (4-W), as indicated on the Plans.
- 9. Dampers: Radial opposed blade.
- 10. Accessories:
 - a. Equalizing grid.
 - b. Plaster ring.
 - c. Sectorizing baffles.

2.2 GRILLES:

A. Fixed Face Grille (RG):

- 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. Anemostat Products; a Mestek company.
 - b. Carnes.
 - c. Titus, Model No. 50F.
- 2. Material: Aluminum.
- 3. Finish: Baked enamel, white.

4. Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
5. Core Construction: Integral.
6. Frame: 1-1/4 inches wide.
7. Mounting: Lay in.

2.3 SOURCE QUALITY CONTROL:

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

- A. Install diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions and referenced standards.
- B. Ceiling-Mounted Outlets and Inlets: Plans indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Engineer for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING:

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 237313 - MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Variable-air-volume, single-zone air-handling units that can be field assembled.

1.2 ACTION SUBMITTALS

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACOR – SUBMITTALS.

B. Product Data: For each air-handling unit indicated.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

C. Delegated-Design Submittal: For vibration isolation and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. 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.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
 - 2. Support location, type, and weight.
 - 3. Field measurements.
- B. Seismic Qualification Data: Certificates, for air-handling units, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-handling units to include in operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.5 SPARE PARTS

- A. Furnish spare parts to the Engineer that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set for each air-handling unit.
 - 2. Gaskets: One set for each access door.
 - 3. Fan Belts: One set for each air-handling unit fan.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. AHRI Certification: Air-handling units and their components shall be factory tested according to AHRI 430, "Performance Rating of Central-Station Air-Handling Unit Supply Fans," and shall be listed and labeled by AHRI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.7 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Manufacturer's warranty period: 18 months from issuance of the Certificate of Compliance.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/200 where "L" is the unsupported span length within completed casings.
- C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 AIR HANDLING UNIT MANUFACTURERS

- A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products from the manufacturer identified on the Contract plans, or an approved equal.

2.3 UNIT CASINGS

- A. General Fabrication Requirements for Casings:

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Casing Joints: Sheet metal screws or pop rivets.
3. Sealing: Seal all joints with water-resistant sealant.
4. Factory Finish for Galvanized-Steel Casings: Apply manufacturer's standard primer immediately after cleaning and pretreating.
5. Factory Finish for Galvanized-Steel Casings: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.
6. Casing Coating: Powder-baked enamel.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

- B. Casing Insulation and Adhesive:

1. Materials: ASTM C 1071, Type I.
2. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from, and including, the cooling-coil section.
 - a. Liner Adhesive: Comply with ASTM C 916, Type I.
 - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
 - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service-air velocity.
3. Location and Application: Encased between outside and inside casing.

- C. Inspection and Access Panels and Access Doors:

1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
2. Inspection and Access Panels:
 - a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
3. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Fabricate windows in fan section doors of double-glazed, wire-reinforced safety glass with an air space between panes and sealed with interior and exterior rubber seals.
 - d. Size: At least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.
4. Locations and Applications:
 - a. Fan Section: Inspection and access panels.
 - b. Access Section: Doors.
 - c. Coil Section: Inspection and access panel.
 - d. Damper Section: Inspection and access panels.
 - e. Filter Section: Inspection and access panels large enough to allow periodic removal and installation of filters.
 - f. Mixing Section: Doors.
 - g. Humidifier Section: Doors.
5. Service Light: 100-W vaporproof fixture with switched junction box located outside adjacent to door.
 - a. Locations: Fan section.

D. Condensate Drain Pans:

1. Fabricated with minimum one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.

- b. Depth: A minimum of 2 inches deep.
 - 2. Formed sections.
 - 3. Double-wall, galvanized-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 - 4. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
 - a. Minimum Connection Size: NPS 1.
 - 5. Pan-Top Surface Coating: Asphaltic waterproofing compound.
 - 6. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.
- E. Air-Handling-Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs. Unit shall be field assembled in place.
 - 1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when air-handling unit frame is anchored to building structure.

2.4 FAN, DRIVE, AND MOTOR SECTION

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
 - 1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - 1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 2. Horizontal-Flanged, Split Housing: Bolted construction.
 - 3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.

4. Flexible Connector: Factory fabricated with a fabric strip 3-1/2 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized-steel sheet or 0.032-inch-thick aluminum sheets; select metal compatible with casing.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
 - 1) Fabric Minimum Weight: 26 oz./sq. yd.
 - 2) Fabric Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3) Fabric Service Temperature: Minus 40 to plus 200 deg F.
- C. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing.
- D. Fan Shaft Bearings:
 1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with a rated life of 50,000 hours according to ABMA 9.
 2. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and 2-piece, cast-iron housing with grease lines extended to outside unit and a rated life of 50,000 hours according to ABMA 11.
 3. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit.
- E. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
 1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5- hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
 3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.
 4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch-thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.
- F. Variable-Inlet Vanes: Steel, with blades supported at both ends with permanently lubricated bearings. Variable mechanism terminating in single lever for connection to control actuator with connecting shaft for second set of variable inlet vanes on double-width fans.

- G. Discharge Dampers: Heavy-duty steel assembly with channel frame and sealed ball bearings, and parallel blades constructed of two plates formed around and welded to shaft, with blades linked out of air stream to single control lever.
- H. Internal Vibration Isolation and Seismic Control: Fans shall be factory mounted with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.
 - 1. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.
- I. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Enclosure Type: Totally enclosed, fan cooled.
 - 2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - 3. 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.
 - 4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - 5. Mount unit-mounted disconnect switches on [exterior] [interior] of unit.
- J. Variable Frequency Controllers:
 - 1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
 - 2. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
 - 3. Unit Operating Requirements:
 - a. Input ac voltage tolerance of 380 to 500 V, plus or minus 10 percent.
 - b. Input frequency tolerance of 06/11 Hz, plus or minus 6 percent.
 - c. Minimum Efficiency: 96 percent at 60 Hz, full load.
 - d. Minimum Displacement Primary-Side Power Factor: 96 percent.
 - e. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
 - f. Starting Torque: 100 percent of rated torque or as indicated.
 - g. Speed Regulation: Plus or minus 1 percent.
 - 4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
 - 5. Internal Adjustability Capabilities:

- a. Minimum Speed: 5 to 25 percent of maximum rpm.
 - b. Maximum Speed: 80 to 100 percent of maximum rpm.
 - c. Acceleration: 2 to a minimum of 22 seconds.
 - d. Deceleration: 2 to a minimum of 22 seconds.
 - e. Current Limit: 50 to a minimum of 110 percent of maximum rating.
6. Self-Protection and Reliability Features:
- a. Input transient protection by means of surge protection device (SPD).
 - b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
 - c. Adjustable motor overload relays capable of NEMA ICS 2, Class 10 performance.
 - d. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
 - e. Instantaneous line-to-line and line-to-ground overcurrent trips.
 - f. Loss-of-phase protection.
 - g. Reverse-phase protection.
 - h. Short-circuit protection.
 - i. Motor overtemperature fault.
7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
8. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.
9. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
10. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
11. Door-mounted LED status lights shall indicate the following conditions:
- a. Power on.
 - b. Run.
 - c. Overvoltage.
 - d. Line fault.
 - e. Overcurrent.
 - f. External fault.
12. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed time meter.
13. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

- a. Output frequency (Hertz).
- b. Motor speed (rpm).
- c. Motor status (running, stop, fault).
- d. Motor current (amperes).
- e. Motor torque (percent).
- f. Fault or alarming status (code).
- g. Proportional-integral-derivative (PID) feedback signal (percent).
- h. DC-link voltage (volts direct current).
- i. Set-point frequency (Hertz).
- j. Motor output voltage (volts).

14. Control Signal Interface:

- a. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
- b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
 - 1) 0 to 10-V dc.
 - 2) 0-20 or 4-20 mA.
 - 3) Potentiometer using up/down digital inputs.
 - 4) Fixed frequencies using digital inputs.
 - 5) RS485.
 - 6) Keypad display for local hand operation.
- c. Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
 - 1) Output frequency (Hertz).
 - 2) Output current (load).
 - 3) DC-link voltage (volts direct current).
 - 4) Motor torque (percent).
 - 5) Motor speed (rpm).
 - 6) Set-point frequency (Hertz).
- d. Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
 - 1) Motor running.
 - 2) Set-point speed reached.
 - 3) Fault and warning indication (overtemperature or overcurrent).
 - 4) High- or low-speed limits reached.

15. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.

16. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.
17. Accessories:
 - a. Devices shall be factory installed in controller enclosure unless otherwise indicated.
 - b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
 - c. Standard Displays:
 - 1) Output frequency (Hertz).
 - 2) Set-point frequency (Hertz).
 - 3) Motor current (amperes).
 - 4) DC-link voltage (volts direct current).
 - 5) Motor torque (percent).
 - 6) Motor speed (rpm).
 - 7) Motor output voltage (volts).

2.5 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with AHRI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.
5. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.
6. Corrosion-Resistant Coating: Coat coils with a corrosion-resistant coating capable of withstanding a 3,000-hour salt-spray test according to ASTM B 117.
 - a. Standards:
 - 1) ASTM B-117 for salt spray.
 - 2) ASTM D-2794 for minimum impact resistance of 100 in-lb.
 - 3) ASTM B-3359 for cross-hatch adhesion of 5B.
 - b. Application: Immersion.
 - c. Thickness: 1 mil
 - d. Gloss: Minimum gloss of 50 gloss units on a single-angle 60-degree meter.
 - e. UV Protection: Spray-applied topcoat.

2.6 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Comply with NFPA 90A.
2. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
3. Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

B. Disposable Panel Filters:

1. Factory-fabricated, viscous-coated, flat-panel type.
2. Thickness: 1 inch.
3. Arrestance (ASHRAE 52.1): 80.
4. MERV (ASHRAE 52.2): 5.
5. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
6. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, hinged, and with pull and retaining handles.

C. Filter Gage:

1. 2-inch-diameter, diaphragm-actuated dial in metal case.
2. Vent valves.
3. Black figures on white background.
4. Front recalibration adjustment.
5. 2 percent of full-scale accuracy.
6. Range: 0- to 0.5-inch wg.
7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing, and 2- or 3-way vent valves.

2.7 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 2 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."

C. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
 3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
 6. Size dampers for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
 7. Coupling: V-bolt and V-shaped, toothed cradle.
 8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
 10. Power Requirements (Two-Position Spring Return): 24-V ac.
 11. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 12. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 13. Temperature Rating: Minus 22 to plus 122 deg.
 14. Run Time: 12 seconds open, 5 seconds closed.
- D. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with cadmium-plated steel operating rods rotating in stainless-steel sleeve bearings mounted in a single aluminum frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. ft. at 1-inch wg and 9 cfm/sq. ft. at 4-inch wg.

- E. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
- F. Combination Filter and Mixing Section:
 - 1. Cabinet support members shall hold 2-inch-thick, pleated, flat, permanent or throwaway filters.
 - 2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.8 SOURCE QUALITY CONTROL

- A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- C. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

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 the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for hydronic and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
- F. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
 2. Charge refrigerant coils with refrigerant and test for leaks.
 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- E. Prepare test and inspection reports.

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. Verify that shipping, blocking, and bracing are removed.
 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 6. Verify that zone dampers fully open and close for each zone.
 7. Verify that face-and-bypass dampers provide full face flow.
 8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 9. Comb coil fins for parallel orientation.
 10. Verify that proper thermal-overload protection is installed for electric coils.
 11. Install new, clean filters.
 12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B. Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 TRAINING

- A. Refer to Form 817 Section 1.20-1.08.14 subsection 3 for additional information.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313

SECTION 238126 – SPLIT SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section describes the requirements for a mission critical environmental control system. The system shall be designed to control temperature and humidity conditions in rooms containing electronic equipment. The manufacturer shall design and furnish all equipment to be fully compatible with the heat dissipation requirements of the room. The equipment shall be provided with a high sensible cooling system, factory assembled, piped, wired, and run tested prior to shipment and designed down flow air delivery as detailed in the Contract.

1.2 DEFINITIONS

- A. CRAC: Computer Room Air Conditioning
- B. BAS: Building Automation System
- C. DX: Direct Expansion
- D. EC: Electronically Commutated
- E. EEV: Electronic Expansion Valve
- F. TXV: Thermal Expansion Valve

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
 - 1. Product Data: For each type of product indicated include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories
 - 2. Shop Drawings: Single-line diagrams; dimensional, capacity data; and piping.
 - 3. Wiring Diagrams: For power, signal, and control wiring.
 - 4. Manufacturer Documentation certifying that all materials, products, components and test reports are in compliance with the design requirements for this Project.
- B. Operation and Maintenance Data: For equipment to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.
- C. Warranty: As specified herein.

1.4 DESIGN REQUIREMENTS

- A. The DX CRAC equipment shall be a self-contained factory assembled, piped, wired and factory run tested prior to shipment.
 - 1. The units shall have downflow airflow delivery.
 - 2. The total cooling capacity (total and sensible), entering air conditions, air flow and electrical power requirements shall be as detailed on the project plans and schedule.
 - 3. Net capacities shall include losses due to fan motor heat.
 - 4. Quantities and configurations as shown on the project drawings.
 - 5. Safety Certification: Units shall be ETL or UL listed in accordance with UL-1995.

1.5 PERFORMANCE REQUIREMENTS

- A. Performance requirements for the DX CRAC equipment following the formal acceptance and throughout the life of the product.
 - 1. The equipment provided should meet the capacity expectations stated in the Contract and continue to meet functional, reliability, and performance requirements of this contract after final acceptance
 - 2. In the event that the equipment fails to meet any requirements of this specification and the project plans and schedule after acceptance and during the warranty period, the manufacturer shall take appropriate steps to correct the problem and bring the equipment back into compliance with the performance and reliability requirements at no cost to the Engineer.

1.6 QUALITY ASSURANCE

- A. The manufacturer shall define and manage a process necessary to ensure that product and/or service conforms to customer requirements. As a means of implementing and demonstrating the defined processes, establish a quality management system in accordance with ISO 9001 International Standard.
- B. All CRAC equipment shall be fabricated by companies whose primary business expertise is the manufacturing of commercial and industrial quality CRAC units. The manufacturer shall have been in continuous operation in the manufacture of the products specified for a minimum of ten (10) years.
- C. Product Safety: Product shall comply with North American safety standards. Tested by one of the following and bearing label indicating conditions of use:
 - 1. Intertek (ETL Listed Mark)
 - 2. Underwriters Laboratories, Inc. (UL)

1.7 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Manufacturer's warranty period: 18 months from the issuance of the Certificate of Compliance.

1.8 SPARE PARTS

- A. Furnish spare parts to the Engineer that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One (1) set of filters for each unit.

PART 2 - PRODUCTS

2.1 DIRECT EXPANSION COMPUTER ROOM AIR CONDITIONING EQUIPMENT

- A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide products from the manufacturer identified on the Contract plans, or an approved equal.

2.2 CAPACITIES AND CHARACTERISTICS

- A. The quantity, capacity, and performance shall be as shown on the Contract plans.

2.3 GENERAL REQUIREMENTS

- A. Description: The environmental control, direct expansion CRAC equipment shall be provided with a high sensible cooling system, self-contained, factory assembled, piped, wired, and factory tested prior to shipment. Units shall include an enclosure/cabinet assembly, fan section, filter section, cooling coil, controls, and interconnecting piping internal to unit.
- B. Cabinet and Frame:
 - 1. Frame: Constructed of welded 14 gauge tubular steel, braced for rigidity, supporting mechanical equipment. Coated with a heavy corrosion inhibiting finish for long life.
 - 2. Front and Side Access: The unit shall have complete front and side access by means of steel doors with heavy-duty hinges.
 - 3. Doors: Fabricated of 18-gauge steel for superior sound attenuation. All doors shall be easily removable via lift-off hinges for easier service access.

4. Door Latches: Two (2) manually actuated via a hand tool, sure close ¼ turn door latches.
5. Gaskets: Each door shall be provided with polyurethane gaskets to prevent air leakage.
6. Finish of Exterior Surfaces: Powder coated with a heavy corrosion inhibiting finish for long life. The unit shall be the color selected from the manufacturers standard color selection chart.
7. Rear panel: Fabricated with 18-gauge steel sheet metal for superior sound attenuation.
8. Insulation: Thermally and acoustically insulate cabinet interior lined with 1 inch thick, 1-1/2-pound density fiber insulation.
9. Condensate Drain Pan: Constructed of stainless steel and provide a positive drain to prevent standing water in the condensate pan.

C. Fans Section:

1. The supply air fans shall be single width, single inlet plenum fan with backward inclined blades. Fan wheel shall be directly connected to its motor for greater efficiency. Fan/motor assembly shall be statically and dynamically balanced for quiet, vibration-free operation. Fan shall be maintenance free throughout its operating life.
2. The fan motor shall be an electronically commutated (EC) synchronous DC motor; commonly referred to as EC fans, having soft start capability and shall be controlled via the unit mounted controller and automatically regulated through all modes of operation.
3. Each fan shall have fault monitoring circuitry and integral speed controller for a level of redundancy.
4. The fan shall be mounted within the unit and fully enclosed in a sheet metal enclosure to prevent access to moving parts.
5. The system shall be designed for draw through air arrangement to ensure even air distribution to the entire face of the coil.
6. In the event of a fan failure, the remaining fans will automatically increase in speed to temporarily deliver as much air flow as possible to the controlled space until the failed fan can be repaired or replaced.
7. Belt drive fans with variable frequency drives are not considered equal or acceptable.

D. Filtration:

1. The filter chamber shall be an integral part of the system, designed within the unit for easy front accessibility.
2. An initial set of filters shall be factory installed in the unit.
3. Filters shall be 4-inch deep, disposable, pleated design, extended-surface, nonwoven, reinforced synthetic fibers; supported and bonded to welded-wire grid; enclosed in a heavy-duty moisture-resistant beverage board frame design.
4. Rated not less than MERV 8 per ASHRAE Std. 52.2.
5. A filter differential switch for alarm activation shall be included.

E. R-410A Refrigerant: The system shall be designed for use with R-410A refrigerant, which meets the U.S. Clean Air Act for phase-out of HCFC refrigerants. Refrigerant shall be field-supplied and field-charged by the installing contractor.

F. Refrigeration System:

The refrigeration system shall consist of (2) independent refrigeration circuits, scroll compressors with vibration isolating grommets, evaporator coils, thermostatic expansion valves, liquid solenoid valves, high and low pressure safety switches, liquid line filter driers, and refrigerant sight glass with moisture indicators. Compressors shall be located outside the airstream and shall be removable and serviceable from the front of the unit. The high and low-pressure safety switches shall be installed with Schrader type fittings with valve core that allows replacement without affecting the refrigerant charge, making recovery unnecessary.

1. Fixed Speed Compressor

- a. The unit shall be configured with a suction gas cooled motor fixed speed hermetic scroll compressor based on temperature set-point plus dead band control through the micro-processor controller.
- b. The compressor shall have a complete overload protection on all three power lines, internal thermostats, rotolock service valve, crankcase heater, sight-glass, and low pressure override timer for positive starting at low temperatures.

2. Direct Expansion Evaporator Cooling Coil

- a. Arrangement: The direct expansion cooling coil shall be in an "A" frame arrangement to allow maximum coil surface in a small cabinet.
- b. Coils: Shall be constructed of seamless, rifled copper tubes expanded into enhanced style aluminum fins for maximum heat transfer.
- c. Face Velocity: Shall be less than 500 feet per minute.
- d. Maximum Working Pressure: Shall be 450 PSI.
- e. Drain Pan: Coil shall sit in a stainless steel drain pan sloped for drainage. A properly sized condensate drain trap shall be furnished by manufacturer and externally piped by the installing contractor.
- f. The suction or discharge (hot gas) and liquid refrigerant piping ports are sealed and pressurized with dry nitrogen for shipment to indicate a leak-free system at installation.
- g. Refrigerant pipe connections shall be terminated three (3) inches inside the bottom of the cabinet for field connection to piping coming from below.

3. Expansion Valve

The expansion valve controls the amount of refrigerant flow into the evaporator thereby controlling the superheating at the outlet of the evaporator.

- a. Electronic Expansion Valves (EEV)
 - 1) The electronic expansion valves shall be an electronic expansion type control by a dedicated driver. This driver shall communicate with the controller via Modbus and shall have the ability to display superheat setpoint, suction temperature, suction pressure, and EEV opening position.
 - 2) The controller shall have the ability to display these alarms:
 - Low suction pressure
 - High suction pressure
 - Low suction temperature
 - High suction temperature
 - Low superheat
 - High superheat
 - EEV Failure
 - EEV Motor Failure
 - Suction temperature sensor failure
 - Suction pressure sensor failure
 - Electronic Valve Driver disconnected
 - 3) The EEV uses a stepper motor for high precision control, allowing a low superheat setpoint with improved system efficiency.
 - 4) The control logic of the EEV shall be based on Proportional-Integral-Derivative (PID) operation via the controller. The P, I and D values shall be factory tested for accurate and robust control.

G. Air-Cooled Split System (with Remote Outdoor Air-Cooled Condenser):

1. The refrigeration system shall be a split system consisting of an indoor evaporator and remote air-cooled outdoor condenser.
2. Remote Outdoor Air-Cooled Condenser
 - a. The remote outdoor air-cooled condenser shall be a low profile with direct drive axial fans with electronically commutated (EC) synchronous DC motors; commonly referred to as EC fans. The EC motors have soft start capability.
 - b. The condenser housing shall be constructed of aluminum and contain a seamless rifled copper tube expanded into aluminum fin coil for maximum heat transfer.
 - c. The air discharge shall be vertical to minimize the effects of wind blowing through the coil at low ambient temperatures.
 - d. The condenser shall have the ability to control the fan speed via a pressure transducer feedback signal to modulate the speed of the fans and provide positive start-up and operation at ambient temperatures down to -20°F.
 - e. All controls including the fan speed control shall be factory mounted in the air cooled condenser in an integral factory wired and tested control panel.

- f. The air cooled condenser shall be manufactured by the manufacturer of the indoor evaporator unit.
- g. The evaporator and condenser shall be factory assembled and tested.
- h. Piping and wiring between the indoor evaporator and the remote outdoor air-cooled condenser shall be field provided by the installing contractor.

H. Air-Cooled with Remote Outdoor Condensing Unit:

- 1. The refrigeration system shall be a split system consisting of an indoor evaporator and remote air-cooled outdoor condensing unit.
- 2. Remote Outdoor Air-Cooled Condensing unit
 - a. The remote outdoor condensing unit shall contain the hermetic scroll compressor with complete overload protection on all three power lines, internal thermostats, crankcase heater, sight-glass, and low pressure override timer for positive starting at low temperatures.
 - b. The unit shall be a low profile with direct drive axial fans with electronically commutated (EC) synchronous DC motors; commonly referred to as EC fans. The EC motors have soft start capability.
 - c. The housing shall be constructed of aluminum and contain a seamless rifled copper tube expanded into aluminum fin coil for maximum heat transfer.
 - d. The air discharge shall be vertical to minimize the effects of wind blowing through the coil at low ambient temperatures.
 - e. The condensing unit shall have the ability to control the fan speed via a pressure transducer feedback signal to modulate the speed of the fans and provide positive start-up and operation at ambient temperatures down to -20°F.
 - f. All controls including the fan speed control shall be factory mounted in the air cooled condensing unit in an integral factory wired and tested control panel.
 - g. The air cooled condensing unit shall be manufactured by the manufacturer of the indoor evaporator unit.
 - h. The evaporator and condensing unit shall be factory assembled and tested.
 - i. Piping and wiring between the indoor evaporator and the remote outdoor air-cooled condensing unit shall be field provided by the installing contractor.

I. Return Air Temperature and Humidity Sensor:

- 1. The environmental control units shall come standard with an all in one combination return air temperature and humidity sensor.
- 2. The return air temperature shall interface with the microprocessor controller for precision temperature and humidity monitoring and control.
- 3. Discharge air temperature monitoring can be used by selecting the Discharge Air Temperature Sensor option.

J. Electrical:

1. All electrical components, including contactors, relays and control transformers shall be pre-wired and contained in a unit-mounted electrical enclosure with piano-hinged door that shall swing out for easy access and servicing.
2. The control circuit voltage shall be 24 volts AC.
3. The input electrical power shall be as detailed on the project plans and schedule.

K. Electric Reheat:

1. The reheat shall be of the finned enclosed, sheath type, fabricated of stainless steel core sheath with plated fins to withstand moist conditions.
2. The reheat shall be installed on the air discharge side of the cooling coil and shall have (3) stages.
3. The reheat shall be capable of maintaining room dry bulb conditions when the system is calling for dehumidification.
4. The reheat section shall include a safety switches to protect the system from overheating.
5. Low-watt density coils eliminate ionization associated with open air electric resistance heating.
6. The electric reheat requirements shall be as detailed on the project plans and schedule.

L. Humidifier:

1. The unit shall be provided with a self-contained, microprocessor-controlled steam generator type humidifier. The steam generating humidifier shall use disposable cylinder type with electronic controls.
2. The humidifier shall discharge pure steam with no material dust carry-over and have a self-regulating automatic flush cycle. Cylinders shall be disposable not requiring cleaning or maintenance. The humidifier fill level, water conductivity and flush rate shall automatically adapt, both in frequency and duration, to variations in the incoming water.
3. Field-adjustable maximum capacity; with high-water probe.
4. Drain duration and drain interval shall be field-adjustable.
5. Humidifiers using an open reservoir in the air stream are not acceptable.
6. The capacity and power consumption shall be as detailed on the project plans and schedule.

M. Water Detection Sensor:

1. Each unit shall be provided with (1) under floor water detection sensor.
2. The solid-state water detection sensor shall be mounted under the unit by the installing contractor to sense the presence of water.
3. The water detector shall become an integral part of the microprocessor panel and shall display "WATER DETECTED IN UNDER FLOOR AREA" message and activate an audible alarm when the sensor is activated.

4. Additionally, (3) adjustable action settings shall be available when an alarm is detected: Alarm only, shutdown unit or lockout compressor.

N. High Temperature Sensor:

1. The high temperature sensor (Firestat) shall be factory-installed in the unit and shall be factory-set to 125°F. It shall immediately shut down the environmental control system when activated. The sensor shall be mounted with the sensing element in the return air.

O. Microprocessor-Control System:

1. The environmental control system shall be furnished with a microprocessor based panel. The panel shall include unit control functions and display normal functions and service diagnostics on a backlit liquid crystal display (LCD). The panel shall allow recall and display of the high and low temperature for the last 24 hours, high and low humidity for the last 24 hours, current percent of capacity and average percent of capacity for the last hour of operation for chilled water valve (if applicable), compressor (if applicable), reheat, humidification, dehumidification, component runtimes (if applicable) for fan motor(s), reheat, humidification, dehumidification and chilled water valve. Programming shall have multilevel password access to prevent unauthorized access. Programming shall be accomplished entirely from the front of the unit without the need to access, set or program switches inside the unit (front door of the unit does not need to be opened). Programmable functions shall be entered on flash memory to ensure program retention should power fail. The historical database shall be maintained by battery backup. Multiple messages shall be displayed by automatically scrolling from each message to the next. Alarm conditions shall be displayed by automatically scrolling from each message to the next. Alarm conditions, in addition to being displayed, shall enunciate an audible alarm. Four programmable summary contacts shall be available for remote alarm monitoring. Additional test or service terminal shall not be required for any functions. The control shall include temperature anticipation, moisture level humidity control and automatic flush cycles.
2. An alarm condition shall continue to be displayed until the malfunction is corrected. Multiple alarms shall be displayed sequentially in order of occurrence and only those alarms which have not been acknowledged shall continue to sound an audible alarm. The control panel shall perform an automatic self-test on system start-up. A user accessible diagnostic program shall aid in system component trouble shooting by displaying on the unit LCD screen the name of the controlled item, output relay number, terminal plug and pin number for each controlled item.

3. The following automatic control functions shall be included (as applicable):

Selectable Water Under Floor Alarm	Start Time Delay
Temperature Anticipation	Automatic or Manual Restart
Dehumidification Lockout	Humidity Anticipation
Sequential Load Activation	Chilled Water Coil Flush Cycle
Latent Anticipation	Suction Pressure

4. The following conditions, data and normal functions shall be monitored and displayed (as applicable):

Current Date and Time	Unit Status
Temperature Setpoint	Humidity Setpoint
Current Temperature	Current Humidity
Cooling	Dehumidification
Reheat	Humidification
Current Percent of Capacity Utilized	Current Discharge Temperature*
Current Fan Speed	Current Chilled Water Valve
Position	
Current Rack Temperature 1, 2 and 3	Current Dewpoint*
Max Rack Temperature	

5. The following switching and control functions shall be included:

Alarm Silence Button	Select Buttons (Up and Down)
Menu Selection Button	Enter Button (Menu Exit/Program
Set)	
System On/Off/Esc Button	
Manual Override switches (as applicable): for:	
Cooling	Reheat
Humidification	CW Valve
Fan ON/OFF and Speed	

6. The following alarm functions shall be monitored and displayed when they occur in addition to enunciating an audible alarm (as applicable):

High Temperature Warning	High Humidity Warning
Low Temperature Warning	Low Humidity Warning
Under Floor Water Detection	Dirty Filter
Power Failure Restart	Manual Override
Firestat Tripped	Humidifier Problem
Maintenance Required	Local Alarm
Humidity Sensor Error	Discharge Sensor Error
No Water Flow*	Custom Message*
Smoke Detector*	High Condensate Water Level*
Fan Motor Overload*	Person to Contact on Alarm*
Rack Temperature Sensor Error 1, 2*, 3*	High Suction Pressure
Low Suction Pressure	High Pressure Alarm

7. The following historical data shall be available(as applicable):

High Humidity Last 24 Hours	Low Humidity Last 24 Hours
Alarm History (Last 100 Alarms)	Hourly Average of Duty
Rack Temperature Max last 24 Hours	Rack Temperature Min last 24 Hours
Rack Temperature Average Last 24 Hours	
Equipment Runtimes for:	
Fan(s)	Compressor
Reheat	Dehumidification
Humidifier	Chilled Water Valve

8. The following functions shall be programmable(as applicable):

Temperature Setpoint	Temperature Deadband
High Temperature Alarm Limit	Low Temperature Alarm Limit
Humidity Setpoint	Humidity Deadband
High Humidity Alarm Limit	Low Humidity Alarm Limit
Reset Equipment Runtimes	Audio Alarm Mode
Manual Diagnosis	Humidity Anticipation
Dehumidification Mode	Low Discharge Temp Alarm Limit
Power Problem or Restart Mode	System Start Delay
Message for Optional Alarm 1, 2, 3, 4*	Delay for Optional Alarm 1, 2, 3, 4*
Remote Alarm 1, 2, 3, 4 Selection*	Person to contact on Alarm
Define Password	Humidifier Autoflush Timer*
Firestat Temperature Alarm Limit	Scheduled Normal Maintenance
Temperature Scale	Calibrate Temperature Sensor
Calibrate Humidity	Humidifier
Water Valve Mode	Water Valve Voltage Range
Reverse Acting Water Valve	Network Protocol
Analog Module Sensor Setup*	Calibrate Discharge Air Sensor*
Calibrate Chilled Water Temp Sensor*	Fan Control Mode
Fan Speed Settings	High Dewpoint Setpoint*
High Dewpoint Deadband*	Low Dewpoint Setpoint*
Low Dewpoint Deadband*	Fan temperature setpoint*
Fan temperature deadband*	Superheat Setpoint
High Suction Pressure Setpoint	High Suction Pressure Deadband
Low Suction Pressure Setpoint	Low Suction Pressure Deadband
Fan Modulation Rate	Return Air Cooling Band
Delta-T Setpoint	SCR Reheat Band*
Latent Anticipation Setpoint*	

* Some of the programmable selections, displays or alarms may require additional components or sensors

9. In addition, the control panel shall support the following network protocols for integration with a Building Management System (BMS) for CRAC system monitoring and control.

The following protocols shall be supported:

Modbus RTU, TCP/IP
BACnet IP or MS/TP

SNMP V1 or V2
LonTalk SNVT

10. Building Management System Interface: Unit(s) shall be furnished with a interface card to communicate directly with the BAS through an RS-485, Ethernet or LonTalk port. All alarms, set points, and operating parameters that are accessible from the unit mounted control panel shall also be made available through the BAS.

2.4 ADDITIONAL REQUIREMENTS

- A. Energy Saver Coil: The environmental control unit shall be provided with an Energy Saver coil. The Energy Saver coil shall be an integral part of the unit and will be capable of providing the total cooling capacity. Whenever the incoming water/glycol temperature is below the setpoint of the water changeover thermostat, Energy Saver cooling shall be available. The Energy Saver shall operate providing there is a need for cooling. The Energy Saver coil shall include 3-way pressure control valves on the condenser circuits and 3-way valve on the economy coil. Common piping for the energy coil and condensers shall be provided.
- B. Energy Saver Coil with Compressor Supplement: Units with Energy Saver coil shall be provided with compressor supplement if the Energy Saver is not sufficient as a stand-alone system. When the incoming water/glycol temperature is below the setpoint of the water changeover thermostat, the Energy Saver shall be enabled. When there is a call for cooling the Energy Saver coil will be used first until the cooling demand exceeds the Energy Saver coil capacity then the compressor shall come on and supplement the needed cooling capacity. A discharge air temperature sensor shall be included for field mounting.
- C. Remote Temperature & Humidity Sensors: Units shall be provided with remote temperature and humidity sensor. The sensor shall be provided in a plastic case for remote mounting. Cable shall be provided for field wiring in 35 feet length.
- D. Discharge Air Temperature Sensor: The environmental control unit shall be provided with a discharge air temperature sensor for field installation on the supply air side air temperature display via controller.
- E. Thru-Door Locking Disconnect Switch: The environmental control unit shall include a non-automatic disconnect switch mounted in the high voltage section of the electrical panel. The operating mechanism shall prevent access to the high voltage electrical components until switched to the "OFF" position. The operating mechanism shall protrude through the exterior door and be lockable in the OFF position.
- F. Smoke Detector: The environmental control unit shall be provided with a smoke detector. The smoke detector shall be mounted with the sensing element in the return air stream. When the smoke detector is activated, it shall immediately shut down the unit. Refer to CSI Division 28 for smoke detector requirements to integrate into project.

- G. Condensate Pump: Units shall be provided with dual float condensate pump. If condensate pump fails control panel shall enunciate an alarm and display. Pumps shall be factory mounted/wired and shall include sump, motor, and automatic control. A factory installed high condensate water level alarm switch will disable the unit prior to condensate pan overflow should the drain become plugged with debris. The audio alarm is activated and a "HIGH CONDENSATE WATER LEVEL" message shall be displayed on the display module. The pumps shall be rated for 130 GPH at 20 foot of water.
- H. Tandem Scroll Compressors: The environmental control unit shall be provided with tandem hermetic scroll compressors with two-step modulation for stage control. Each circuit shall contain two scroll compressors. Modulation shall allow one or both compressors (per circuit) to run depending upon the load of the system, resulting in part-load efficiency equal to full load efficiency.
- I. Hot Gas Bypass - The environmental control unit shall be provided with hot gas bypass. The hot gas bypass valve shall be installed between the compressor discharge line and the leaving side of the expansion valve through a side outlet distributor.
- J. High Efficiency Filters: Replace the standard MERV 8 filter with MERV 11 (based on ASHRAE Std. 52.2) disposable filters. The filters shall be 4-inch deep pleated design.
- K. Pre-Filters: The environmental control unit shall have 1-inch disposable pre-filters in addition to the unit filters.
- L. Modulating Humidifier: The environmental control unit shall be provided with a 0 to 100% modulating humidifier feature which matches its output to the signal from the humidity control of the control panel.
- M. Cable Type Water Detection Sensor: Units shall be provided with cable type water detection system designed to detect the presence of water anywhere along the cable. Cable shall be mounted on the floor under the unit. Sufficient length of cable shall be supplied to completely surround the perimeter of the unit so that water coming from anywhere within the unit will not escape detection. The water detector shall become an integral part of the microprocessor panel and shall display "WATER DETECTED IN UNDER FLOOR AREA" message and activate an audible alarm when the sensor is activated.
- N. Top Pipe Connections: Chilled water pipe connections shall be terminated (3) inches inside the top of the cabinet for field connection to piping coming from above.
- O. Heavy-Duty Insulation: In lieu of the standard 1-1/2-pound insulation, the environmental control unit shall be thermally and acoustically insulated cabinet interior with 1 inch thick, 3-pound density fiber insulation.
- P. Double Wall Panel and Door Construction: The exterior panels and doors shall be internally lined with 18 gauge sheet metal, sandwiching the insulation between the panels, for easy cleaning.

- Q. SCR Reheat Control: A separate modulating device is enabled through the dap4™ controller to send a variable signal to the SCR adjusting the current output to the reheat elements to achieve tight temperature control.
- R. Phase Loss Relay: Phase loss relay is used to shut down the environmental control unit on the loss of any phase of power. Three phase (3-Ph) equipment only. Automatic reset.
- S. Wire in Conduit: High voltage power wires are isolated in flexible conduit.
- T. Interface Card: The interface card shall provide web-management capability by means of an Ethernet network interface to monitor and control a Data Aire precision cooling systems. The interface card is an Ethernet network card with browser based application software installed on the card which allows a standard desktop or laptop PC to communicate with the microprocessor controller using an open web browser application such as Windows Internet Explorer, Mozilla Firefox or Google Chrome.
- U. Rack sensor: The rack sensor shall connect the unit controller with up to 32 rack inlet temperature sensors for monitoring and/or control. With rack temperature sensors the unit shall maintain the inlet air temperature of the server racks or cold aisle temperature within a desirable temperature range while providing energy savings. The unit shall adjust the chilled water valve or compressor cooling stages to maintain cold aisle or return air temperature while the fan speed is controlled independently by rack inlet temperature sensors.
- V. Automatic Lead/Lag Panel: Unit shall be furnished with an automatic lead/lag control panel. Panel shall be capable of controlling a minimum of (4) units. Upon occurrence of an alarm on one of the primary units, the panel shall automatically shut down the primary unit and start standby unit(s) as required. In addition the panel shall rotate the primary and standby units after a user programmable number of hours to ensure reliable operation and equalize run hours on all units
- W. Zone Master Operation: Each unit shall be furnished with capability to function as the zone master and control the operating mode of up to 16 units located in the same zone. Capabilities shall include:
 - 1. Unit lead/lag and standby rotation with an 8 hours to seven days schedule
 - 2. Unit auto changeover by selectable standby or off (critical) alarms
 - 3. Standby unit activation by average zone temperature
 - 4. Zone functions inhibit preventing units from conflicting operation
 - 5. Secondary operating schedule for an economical control solution
 - 6. Programmable unit's status control (On/Off/Standby)
 - 7. Master unit fail safe mode allows slave units to revert their self-control mode
 - 8. Zone's blower operation based on maximum rack temperature within the zone
- X. Floor Stand: Down flow unit(s) shall be provided with floorstand and vibration isolation pads. The floorstand shall be a completely welded structural angle base frame

engineered to support the operating unit. The floorstand height shall be 15 inches with adjustable legs

- Y. Floor Stand Turning Vane: A factory-supplied, field-mounted turning vane shall be provided.
- Z. Vibration Isolation Pads: Vibrations isolation pads consisting of high density cork sandwiched between two layers of neoprene shall be supplied for field mounting.
- AA. Extended Return Air Plenum: Down flow units shall be equipped with a four-sided inlet plenum on the return to extend the return air opening of the unit. Plenums shall be of sufficient height to penetrate the lay-in ceiling. If lay-in ceiling is not used plenum height shall sufficient to extend the return air opening to within 10-inches of the deck above or 6 feet whichever is shorter. Plenum shall be un-insulated, constructed of minimum 18 gauge steel and powder coated to match the color of the unit on which it is mounted

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor to examine the areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where equipment will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install precision cooling units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Install in conjunction with server cabinets for integrated line up of equipment.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Plans indicate general arrangement of piping, fittings, and specialties.
- B. Piping Connections: Connect equipment furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's piping connection diagram submittal to piping contractor. Install piping to allow proper service and maintenance.
- C. Electrical Wiring: Install and connect electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's electrical connection diagram submittal to electrical contractor.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, assist in testing, and adjust components, assemblies, and equipment installations, including connections.

3.5 TRAINING:

- A. Refer to Form 817 Article 1.20-1.08-14 subsection 3 for additional information.
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the equipment.

END OF SECTION 238126

SECTION 238233 - CONVECTORS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes hydronic convectors.

1.2 ACTION SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories. Include manufacturer's standard color charts showing the full range of colors available for units with factory-applied color finishes. A color selection will not be made until it can be coordinated with other required color selections.
 - 1. Spare Parts: Include name, address, and telephone number of in-state supplier of spare parts. No out-of-state suppliers shall be permitted.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, and 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. Include details and dimensions of custom-fabricated enclosures.
 - 4. Indicate location and size of each field connection.
 - 5. Indicate location and arrangement of piping valves and specialties.
 - 6. Include enclosure joints, corner pieces, and other accessories.

1.3 INFORMATIONAL SUBMITTALS:

- A. Quality Assurance Submittals:
 - 1. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS:

- A. Operation and Maintenance Data: For convection heating units to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

PART 2 - PRODUCTS

2.1 HOT-WATER CONVECTORS:

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the Plans as manufactured by Modine, or an approved equal.
 - 1. Color: Ivory.
- B. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and rolled into cast-brass headers with inlet/outlet and air vent; steel side plates and supports. Factory-pressure-test element at minimum 100 psig.
- C. Front and Top Panel: Minimum 18 gauge steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.
- D. Wall-Mounting Back and End Panels: Minimum 20 gauge steel.
- E. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
- F. Insulation: 1/2-inch-thick, fibrous glass on inside of the back of the enclosure.
- G. Finish: Baked-enamel finish.
- H. End Pockets: As required to accommodate piping and accessories depicted on the Plans.
- I. Enclosure Style: Sloped top.
 - 1. Bottom Inlet Grille: Punched louver; painted to match enclosure.
 - a. Painted to match enclosure.
 - 2. Top Outlet Grille: Punched louver; painted to match enclosure.
 - a. Painted to match enclosure.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine areas to receive convectors for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of convector.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

- A. Install units level and plumb.
- B. Install air-seal gasketing between wall and recessing flanges or front cover of fully recessed unit.

3.3 CONNECTIONS:

- A. Piping installation requirements are specified in CSI Division 23 Section 232113, "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Plans indicate general arrangement of piping, fittings, and specialties.
- B. Connect hot-water units and components to piping according to CSI Division 23 Section 232113, "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
 - 1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.
- C. Install control valves as required by CSI Division 23 Section 230900, "Instrumentation and Control for HVAC."
- D. Install piping adjacent to convectors to allow service and maintenance.

3.4 FIELD QUALITY CONTROL:

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Convectors will be considered defective if they do not pass tests and inspections.

- C. Prepare test and inspection reports.
- D. Straighten bent fins on each convector according to manufacturer's recommendations to the satisfaction of the Engineer.

END OF SECTION 238233

SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.
- B. Related CSI Sections: The following sections contain requirements that relate to this section:
 - 1. Division 26 Section 262726 “Wiring Devices”
 - 2. Division 26 Section 262727 “Floor Box Wiring Devices”.
 - 3. Division 27 Sections for cabling used for voice and data circuits.
 - 4. Division 28 Section 283100 “Fire Alarm System”.

1.2 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For the following products:
 - 1. 600 volt insulated wires and cables, all sizes
 - 2. All terminals, lugs and wire connectors
 - 3. Specialty cable including but not limited to fire alarm systems

1.6 INFORMATIONAL SUBMITTALS

- A. Quality Assurance Submittals:
 - 1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.3 QUALITY ASSURANCE:

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the NETA and that is acceptable to authorities having jurisdiction.

2. Testing Agency's Field Supervisor: Person currently certified by the NETA or the NICET 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 NFPA 70.
- D. Comply with FM Global Data Sheets, 5-1, 5-7, 5-8.

1.4 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver wires and cables according to NEMA WC 26.

1.5 COORDINATION:

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Engineer.

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. Wires and Cables:
 - a. Alcan Aluminum Corporation; Alcan Cable Div.
 - b. American Insulated Wire Corp.; Leviton Manufacturing Co.
 - c. BICC Brand-Rex Company.
 - d. Carol Cable Co., Inc.
 2. Connectors for Wires and Cables:
 - a. AMP Incorporated.
 - b. General Signal; O-Z/Gedney Unit.
 - c. Monogram Co.; AFC.
 - d. Square D Co.; Anderson.

2.2 BUILDING WIRES AND CABLES:

- A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Wire and Insulation Applications".
- B. Rubber Insulation Material: Comply with NEMA WC 3.
- C. Thermoplastic Insulation Material: Comply with NEMA WC 5.
- D. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.
- E. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.
- F. Conductor Material: Copper.
- G. Stranding: Stranded conductor.
- H. General:
 - 1. The Contract plans show the locations, type, size and number of wires and cables to be used for this Contract. Each type shall comply with the Specifications contained herein.
 - 2. Cables which have been manufactured more than two years prior to installation will not be accepted.
 - 3. The conductors, unless otherwise noted, shall be soft or annealed copper conforming to ANSI/ASTM B 33 if coated, ANSI/ASTM B 3 if uncoated. In addition, unless otherwise specified, stranded conductors shall have concentric stranding as per ANSI/ASTM B 8.
 - 4. Cables shall be supplied with both ends of each length sealed against the entry of moisture.
- I. 600 Volt Insulated Wires and Cables:
 - 1. General:
 - a. Power, instrumentation, lighting, grounding, and control cable shall be approved for use in wet or dry locations, indoors or outdoors in raceway, wireways, trenches, conduits, underground ducts.
 - b. Asbestos, in any form, is prohibited from the cable. This prohibition includes such items as fillers and binding tapes even though the item is encapsulated, or the asbestos fibers are impregnated with binder material.
 - c. All conductors shall be copper, insulated, 600 Volt, unless otherwise noted. Wire size No.8 and smaller shall be type THHN-THWN, unless otherwise noted or shown; wire size No. 6 AWG and larger

shall be type THWN or XHHW. Type SF-1 or SF-2 shall be used for connections to lighting fixtures.

- d. Conductors with higher insulation temperature rating shall be provided as required. Wiring run through continuous fluorescent fixtures shall be rated 90°C, 194°F. Conductors shall be rated and of a type approved for the specific application.
- e. All conductors shall be installed in raceways except as stated in the next paragraph. Refer to CSI Division 26 Section 262726, "Wiring Devices", and CSI Division 26 Section 262727 "Floor Box Wiring Devices".
- f. Metal-clad cable (MC) may be used in lieu of metallic raceways for fixture "whips" only unless otherwise noted on plans. MC cable shall be rated 600 V and shall include a green insulated copper grounding conductor. An appropriate anti-short device shall be installed at all terminal points.
- g. Conductor and conduit sizes shown on the drawings are based on copper conductors with Type THWN or XHHW insulation, unless otherwise noted. Increase conductor and conduit sizes as necessary for other approved insulation types.
- h. Aluminum is not approved for conductors or wire.
- i. Power conductors shall be a minimum of No. 12 AWG stranded unless otherwise noted. All wire shall be stranded unless otherwise noted. Control conductors shall be a minimum of No. 14 AWG stranded, unless otherwise noted.
- j. When the distance from the panel to the first outlet on a 20 Amp 120 Volt circuit exceeds 100 feet and on a 20 Amp 208 Volt circuit exceeds 200 feet, the conductor shall be increased to No. 10 AWG.
- k. Wires, conductors, and cables shall be single conductor, except as otherwise specified or indicated on drawings.
- l. Cable meeting special requirements such as twisted pairs, triads, or individual shielding shall be provided where recommended by the system manufacturer.
- m. Conductor insulation shall be color coded.

	<u>208Y/120 Volt</u>
Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Ground	Green

- n. Switch leg wiring shall be of the same color code as the corresponding phase.
- o. System color coding shall be in accordance with color code furnished by system manufacturer and shown on wiring diagrams.

- p. Colors, except colors for conductors No. 4 AWG and larger, shall be factory applied the entire length of the conductors by solid color compound, solid color coating, or colored striping or bands, 2 sets 180° apart. Onsite coloring shall not be done, except color coding by means of paint or tapes is approved only for conductors No. 4 AWG and larger.
- q. Voltage rating, manufacturer, type and conductor AWG size indication shall be continuous; factory applied the entire length of each conductor.
- r. Joints and splices shall be made in a manner equivalent electrically and mechanically to the conductor itself. Connections shall be of the pressure or compression type.
- s. Mineral insulated (MI) cables shall be composed of solid copper conductors with magnesium oxide insulation, firmly encased in seamless copper sheet rated 600 V. Minimum size No. 12 two conductors.
- t. All lugs terminating feeder conductors shall be of the solderless type UL listed for use with copper wire. All lugs and terminals shall be UL listed for 90°C applications.
- u. Branch circuit connections or joints shall have an approved type solderless connector suitable for copper conductors.
- v. Wire connectors shall consist of a phenolic compound body with a cone-shaped coil spring insert and threaded skirt. Outer shell shall be knurled for each grip and capable of use with a wrench or pliers.

C. Proprietary Fire Alarm Signal Cable:

1. General:

- a. Conductors shall be UL listed.
- b. Individual conductor color coding of multi-conductor cable shall be in accordance with ICEA Publication S-61-402, Method No. 1.
- c. Size of conductors and number of pairs shall be as shown on the Contract Drawings and per the system manufacturer's requirements.

2. Construction Details:

- a. Conductors shall be annealed copper per ASTM B 3 requirements.
- b. Insulation shall be 0.018 inch minimum average extruded FEP teflon over the individual conductors.
- c. Components shall be cabled together with 25 percent overlap Teflon glass tape.
- d. Outer jacket shall be FEP teflon 0.025 inch minimum thickness, colored Fire Department Red.
- e. Cable shall be marked "FIRE ALARM SERVICE" at regular intervals throughout its length.

- f. Voltage Rating: 600 volts; temperature rating 200 degrees Centigrade.
- g. Stranded conductors shall have seven strands.
- h. Smoke Detector Wires: Conductors shall be solid, paired, shielded.
- i. Speaker Wires:
 - (1) Conductors shall be stranded.
 - (2) Shield shall be aluminum/polyester, spiral wrapped, 25 percent overlap on individual pairs.
 - (3) Drain wire shall be full size stranded.

2.3 CONNECTORS AND SPLICES:

- A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications."

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRE AND INSULATION APPLICATIONS:

- A. Service Entrance: Type RHW or THWN, in raceway.
- B. Feeders: Type THHN, in raceway.
- C. Feeders: Type THWN, in raceway.
- D. Branch Circuits: Type THHN/THWN, in raceway.
- E. Fire Alarm Circuits: Power-limited, fire-protective, signaling circuit cable.
- F. Class 1 Control Circuits: Type THHN, in raceway.
- G. Class 1 Control Circuits: Type THWN, in raceway.

H. Class 2 Control Circuits: Power-limited cable, concealed in building finishes.

3.3 INSTALLATION:

A. General:

1. All conductors shall be installed in concealed metal raceways, RSC, IMC and EMT, in accordance with the NEC except where specifically noted otherwise. Exposed wiring shall be installed in metal raceways. Exposed wiring in finished areas shall be installed in surface metal raceways.
2. Terminals shall be arranged phase A-B-C or 1-2-3 from left to right, top to bottom, and front to back.
3. Branch circuit phase wires shall be connected to separate phases of supply mains to assure balanced condition in that circuit and proper load balance on the panel. Circuit numbers assigned on drawings are used for convenience and need not necessarily designate the circuit on the panel to which that circuit may be connected. Actual circuiting shall suit job conditions.
4. Equipment requiring electric service is also named on the drawings or schedules of other disciplines, or in other Sections. Where receptacles or convenience outlets are specified to serve named equipment, the Contractor shall provide approved receptacle, plug, connection, and/or liquid-tight flexible conduit to equipment.
5. Drawings do not necessarily indicate the required number of conductors in each raceway. Unless it is specifically noted that raceways are empty by the word "empty", the Contractor shall provide all required conductors, power, control, supervisory, alarm, or branch circuits. The Contractor shall make all final connections, flexible or fixed, as required, to all equipment requiring final electrical connections.
6. Regardless of the number of conductors shown, each circuit (conductors No. 8 and smaller) to panels or equipment shall contain a full size neutral conductor, which, if not utilized, shall be taped and insulated at the final point of connection to equipment.
7. All grounding conductors shall have green color coded insulation and shall be sized in accordance with the NEC.
8. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."

9. Pull Conductors: 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.
10. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
11. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
12. Support cables according to CSI Division 26 Section 260500, "Common Work Results for Electrical."
13. Seal around cables penetrating fire-rated elements according to CSI Division 7 Section 078410, "Firestopping".

3.4 CONNECTIONS:

- A. Conductor Splices: Keep to minimum.
- B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors are being spliced.
- C. Use splice and tap connectors compatible with conductor material.
- D. Use oxide inhibitor in each splice and tap connector for aluminum conductors.
- E. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches (300 mm) of slack.
- F. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
- G. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL:

- A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
- B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.
- B. Related CSI Sections include the following:
 - 1. Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables".
 - 2. Division 26 Section 260533, "Raceways and Boxes for Electrical Systems".
- C. System grounding shall be as shown on the plans. All grounding conductors incorporated to the existing system shall be approved by the Engineer.

1.2 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For the following:
 - 1. Grounding Conductors & Connectors.
- C. Qualification Data: For firms and persons specified in Part 1.3, "Quality Assurance".
- D. Field Test Reports: Submit written test reports to include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.3 QUALITY ASSURANCE:

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the NETA and that is acceptable to authorities having jurisdiction. Testing shall be performed by an independent testing agency.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the NETA 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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Grounding Conductors & Connectors:
 - a. Galvan Industries, Inc.
 - b. Lightning Master Corp.
 - c. Salisbury: W.H. Salisbury & Co., Utility
 - d. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS:

- A. Ground Cable: annealed concentric stranded, copper cable the size shown on the plans and in accordance with ASTM 8 and Article 250 of the NEC. For insulated conductors, comply with CSI Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables".
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.

- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Bare Copper Conductors: Only the counterpoise wire shall be bare copper conductor all other conductor in conduit shall be insulated. Bare Copper Conductor shall comply with the following:
 - a. Assembly of Stranded Conductors: ASTM B 8.
- F. Copper Bonding Conductors: Bonding conductor shall be as specified below or according to the plans:
 - a. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - b. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - c. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- G. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS:

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions. Below-grade (embedded or buried) copper grounding cable connections shall be made by exothermic welding. Exothermic welded connectors shall be Erico products Company, Cadweld or approved equal. Bolted connectors shall be acceptable for application where the ground rod or equipment requires periodically disconnection/connection. Connections to stainless steel cables shall be welded.

PART 3 - EXECUTION

3.1 APPLICATION:

- A. All electrical equipment enclosures and equipment, and all metallic parts of the installation, including metallic conduits, wireways, frames, raised floor, shall be bonded and connected to the nearest ground cable, whether shown on the Plans or

not. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry and similar materials.

- B. In raceways, use insulated equipment grounding conductors. The electrical continuity of wireways and enclosures shall be maintained by bonding. Bonding of electrical raceway and enclosures shall assure electrical continuity and the capacity to conduct safety and fault current that could be imposed. Bonding shall comply fully with Article 250 of the NEC.
- C. Exothermic-Welded Connections: Use for connections to structural steel. Grounding connections shall be made in accordance with the Contract and as specified. Paint, scale, rust, corrosion, and other foreign matter shall be removed from the points of contact on metal surfaces before ground connections are made.
- D. Ground tap connections to equipment shall be made at the points provided on the equipment for grounding in accordance with the equipment manufacturer's recommendations. Connections from ground conductors to the ground buses of panels, and other cabinet-mounted equipment shall be made by means of an acceptable bolted fittings.
- E. All electrical power equipment shall be provided with a ground-fault-current return path. Motors and power receptacles shall utilize a grounded, identified separate grounding conductor in the feeder or branch circuit raceway which connects the motor frame or receptacle to the panelboard ground bus.
- F. All electrical power equipment, other than motors and receptacles, shall be provided with a grounded, identified grounding conductor, unless rigid steel conduit in accordance with NEC 344, is used for the raceway.
- G. The Grounding conductor shall in no case be a system neutral or a current-carrying conductor. Where a circuit consists of two or more power conductors in a conduit or wiring channel, the grounding conductor may be one standard wire size smaller than the power conductor, but in no case smaller than No. 14 nor larger than No. 4/0, and shall be stranded and covered by green insulation. In all cases, the white insulated wire shall be used for the current-carrying neutral only.
- H. Metallic sheaths or shields of shielded cable for power and control shall be terminated by a copper grounding strip provided with a connector for connection to the station ground. The manufacturer of the cable shall furnish instructions for ground termination of shielded cable.

3.2 EQUIPMENT GROUNDING CONDUCTORS:

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and circuits.
- C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
- D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from power panels.
- E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
- F. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V, including VAV'S. Bond conductor to each unit and to air duct.
- G. Signal and Communication Systems: For telephone, voice and data, and other communication systems, provide No. 6 AWG minimum insulated grounding conductor in raceway from ground copper bus bar to each service location, terminal cabinet, wiring closet, and central equipment location.

3.3 INSTALLATION:

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type

connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

- C. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated mechanical equipment. Use braided-type bonding straps.

3.4 CONNECTIONS:

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 2. Make connections with clean, bare metal at points of contact.
 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

1.3 PERFORMANCE REQUIREMENTS

- A. Engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.4 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Nonmetallic slotted support systems.
- C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

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 together with concrete Specifications.

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. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 2. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 4. 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 hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of

conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 2. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 4. Toggle Bolts: All-steel springhead type.
 - 5. Hanger Rods: Threaded steel.
- G. Manufacturers:
 - 1. Appleton Electric Company
 - 2. OZ/Gedney Company
 - 3. B-Line Systems
 - 4. Kindorff
 - 5. Approved Equal

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as NFPA 70. Minimum rod size shall be 1/4 inch 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 two-bolt conduit clamps Retain paragraph below for projects where seismic design requirements do not apply. Consider retaining for light-commercial projects only.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch 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, 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
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts 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 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils
 - 2. Retain first paragraph below if a painting Section is in Project Manual.
- B. 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 SUMMARY:

A. Section Includes:

1. Raceways include the following: RGSC, EMT, LFMC, FMC, and wireways.
2. Boxes, enclosures, and cabinets include the following: Device boxes, outlet boxes, pull and junction boxes, cabinets and hinged-cover enclosures.

B. Related CSI Sections include the following:

1. Division 07 Section 078413, "Penetration Firestopping"
2. Division 26 Section 260519, "Low Voltage Electrical Power Conductors and Cables".
3. Division 26 Section 260526, "Grounding and Bonding for Electrical Systems".
4. Division 26 Section 260529, "Hangers and Supports for Electrical Systems".
5. Division 26 Section 262726, "Wiring Devices"

1.2 DEFINITIONS:

1. EMT: Electrical metallic tubing.
2. FMC: Flexible metal conduit.
3. LFMC: Liquidtight flexible nonmetallic conduit.
4. RGSC: Rigid galvanized metal conduit.

1.3 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20 -1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.
- C. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
 1. Custom enclosures and cabinets.
 2. For boxes, including the following:

- a. Conduit entry provisions, including locations and conduit sizes
- b. Box cover design
- c. Grounding details
- d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons
- e. Joint details
- f. Seals and expansion fittings

1.4 QUALITY ASSURANCE:

- A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
- B. Comply with NEC's "Standard of Installation."
- C. Comply with NFPA 70.

1.5 COORDINATION:

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

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. Metal Conduit and Tubing:
 - a. Alflex Corp.
 - b. Anamet, Inc.; Anaconda Metal Hose.
 - c. Anixter Brothers, Inc.
 - 2. Conduit Bodies and Fittings:
 - a. American Electric; Construction Materials Group.
 - b. Crouse-Hinds; Div. of Cooper Industries.
 - c. Emerson Electric Co.; Appleton Electric Co.

3. Metal Wireways:
 - a. Hoffman Engineering Co.
 - b. Keystone/Rees, Inc.
 - c. Square D Co.

4. Surface Metal Raceways:
 - a. Airey-Thompson Co., Inc.; A-T Power Systems.
 - b. American Electric; Construction Materials Group.
 - c. Butler Manufacturing Co.; Walker Division.

5. Boxes, Enclosures, and Cabinets:
 - a. American Electric; FL Industries.
 - b. Butler Manufacturing Co.; Walker Division.
 - c. Crouse-Hinds; Div. of Cooper Industries.

2.2 CONDUIT AND TUBING:

- A. All conduits shall be ¾" minimum unless otherwise noted.
- B. RGSC: ANSI C80.1.
- C. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1, ANSI C80.1, UL6, coating thickness: 0.040 inch, minimum.
- D. RNC: NEMA TC2, Type EPC-40-PVC, Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.
- E. EMT and Fittings: ANSI C80.3. Fittings: Set-screw or compression type. Cast fittings shall be made of steel or malleable iron.
- F. LFMC: UL 360, Flexible steel conduit with PVC jacket.
- G. FMC: UL ASNI/UL-1, Zinc-coated steel.
- H. Fittings/Conduit bodies for Metallic Conduit: Comply with NEMA FB 1 and UL 514B; match conduit/tubing materials. Cast fittings shall be made of steel or malleable iron, hot-dip galvanized finish for RGSC. Covers for conduit bodies installed in wet locations shall be gasketed.
- I. Fittings/Conduit bodies RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS:

- A. Material: Sheet metal sized and shaped as indicated. The exterior installed wireways shall be NEMA 3R as indicated on plans. Interior installed wireways shall be NEMA 1.
- B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- D. Wireway Covers: Hinged type.
- E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS:

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
- B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.5 OUTLET AND DEVICE BOXES:

- A. Sheet Metal Boxes: NEMA OS 1.
- B. Steel-Metal Boxes: NEMA FB 1, Type FD, cast box with gasketed cover.
- C. Boxes and fittings: Boxes and fittings shall comply with the applicable provisions of NFPA 70, Article 314.

2.6 PULL AND JUNCTION BOXES:

- A. Small Sheet Metal Boxes: NEMA OS 1.
- B. Cast-Metal Boxes: NEMA FB 1, steel with gasketed cover.

2.7 ENCLOSURES AND CABINETS:

- A. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic finished inside with radio-frequency-resistant paint.
- B. Cabinets: Interior: NEMA 250, Type 1, galvanized steel box. Exterior: NEMA 3R. Hinged door in front covers with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRING METHODS:

- A. Indoors: Use the following wiring methods:
1. Office Areas: EMT inside finished wall and above ceiling. RGSC when surface mounted in office areas.
 2. Electrical Room, Mechanical Room: RGSC up to 10' elevation AFF, EMT over 10' elevation AFF.
 3. Concealed conduit in all finished walls shall be EMT.
 4. Boxes and Enclosures: NEMA 250, Type 1.
- B. Outdoors: Use the following wiring methods:
1. Exposed Conduit: Exposed conduit installed above 2' AFG shall be RGSC. Exposed conduit installed 2' AFG and below shall be PVC coated RGSC in paved areas RGSC in grass areas.
 2. Boxes and Enclosures, Aboveground : NEMA 250, Type 3R.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings.

3.3 INSTALLATION:

- A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions, following NEC and local codes. Install conduit clamps within 3' of boxes and at 10' maximum distance between junction points.
- B. Minimum Raceway Size: 3/4-inch trade size.
- C. Conceal conduit and EMT, unless otherwise indicated, within finished walls and ceilings.
- D. Keep raceways at least 6 inches away from parallel runs of flues and hot-water pipes. Install horizontal raceway runs above water and steam piping.
- E. Install raceways level and square and at proper elevations. Provide adequate headroom.
- F. Complete raceway installation before starting conductor installation.
- G. Support raceways as specified in CSI Division 26 Section 260529, "Hangers and Supports for Electrical Systems."
- H. Use temporary closures to prevent foreign matter from entering raceways.
- I. Stub-ups shall be rigid conduit. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab. RGSC shall be utilized under slab. Under slab installations shall be limited only for the penetration of utilities.
- J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
- K. Use raceway fittings compatible with raceways and suitable for use and location. For rigid steel conduit, use threaded rigid steel conduit fittings.
- L. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
- M. Install exposed raceways parallel or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
 - 1. Run parallel or banked raceways together, on common supports where practical.
 - 2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- N. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 2. Use insulating bushings to protect conductors.
- O. Tighten set screws of threadless fittings with suitable tools.
- P. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box.
- Q. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
- R. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire. Ends shall be capped.
- S. Telephone, Fire Alarm, and Signal System Raceways: 3-Inch trade size and smaller unless otherwise indicated. In addition to the above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent, unless otherwise indicated. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
- T. Install raceway sealing fittings according to manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-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 at the following points:
1. Where otherwise required by NFPA 70.
- U. Stub-up Connections: Extend rigid metal conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor.
- V. Flexible Connections: Use maximum of 6 feet of FMC conduit for equipment subject to vibration, noise transmission, or movement; and for all motors. Install separate ground conductor across flexible connections.
- W. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

- X. Conduits entering enclosures, other than threaded cast boxes, shall be securely fastened by means of two lock-nuts, one on each side of the enclosure. The conduit shall be terminated in a bushing. Conduit bushings made entirely of non-metallic materials shall not be used.
- Y. Do not leave any box openings exposed. Install hole plugs on any knockout holes that are removed without any conduit attached.
- Z. Install boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances. Flush mounted boxes shall be galvanized steel.
- AA. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- BB. 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.
- CC. Where portions of a cable raceway or sleeve are known to be subjected to different temperatures and where condensation is known to be a problem, as in cold storage areas of the building or where passing from the interior to the exterior of the building, the raceway or sleeve shall be filled with an approved material to prevent the circulation of a warm air to a colder section of the raceway or sleeve.
- DD. Raceways shall be provided with expansion fittings where necessary to compensate for thermal expansion and contraction.
- EE. 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.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 PROTECTION:

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the issuance of the Certificate of Compliance.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

3.7 CLEANING:

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 260533

SECTION 260544 – SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Sleeves for raceways and cables.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicon Sealants.

1.2 DEFINITIONS:

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR SUBMITTALS.
- B. Product Data: For sleeve seals and silicon sealants.
- C. Quality Assurance Submittals:
 1. Manufacturer Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.4 COORDINATION:

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in CSI Division 07 Section 078413, "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES:

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Sleeves for Conduits penetrating Non-Fire-Rated Gypsum Board Assemblies: galvanized-steel sheet, 0.0239 inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel.
 - 1. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
 - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.
- D. Coordinate sleeve selection and application of firestopping specified in CSI Division 07 Section 078413, "Penetration Firestopping".

2.2 SLEEVE-SEAL SYSTEM:

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers: Subject to compliance with requirements. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: Interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Carbon steel (Composite material for the Salt Shed). Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel (stainless steel for the Salt Shed) of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 SLEEVE-SEAL FITTINGS:

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.
 - 1. Manufacturers: Subject to compliance with requirements. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Presealed Systems.

2.4 GROUT:

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 SILICONE SEALANTS:

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
 - 2. Sealant shall have VOC content of 43 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR RACEWAYS AND CABLES:

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

- a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in CSI Division 07 Section, Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide ¼ annular clear space between sleeve and raceway unless sleeve seal is to be installed.
 - 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
- 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- F. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.
- G. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in CSI Division 07 Section 078413, "Penetration Firestopping."
- 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION:
- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
 - B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and

sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings

END OF SECTION 260544

SECTION 260548 - SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes vibration and seismic controls for surface conduit and electrical equipment.
- B. Related Sections include the following:
 - 1. CSI Division 26 Section 260529, "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.2 DEFINITIONS:

- A. ICC-ES: ICC-Evaluation Service.

1.3 PERFORMANCE REQUIREMENTS:

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: D.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: IV.
 - a. Seismic Design Category. C.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second)(S_{DS}): 0.182.
 - 4. Design Spectral Response Acceleration at 1.0-Second Period S_{D1} : 0.064.

1.4 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

- a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Restrained-Isolation Devices: Include ratings for horizontal, vertical, and combined loads.
- C. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators and seismic restraints.
 - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other CSI Division 26 Sections for equipment mounted outdoors.
 2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
 3. Field-fabricated supports.
 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- D. Quality Assurance Submittals:
 1. Welding certificates.
 2. Qualification Data: For professional engineer and testing agency.
- E. Field quality-control test reports.

1.5 QUALITY ASSURANCE:

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
- E. Comply with NFPA 70.

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.
- B. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene, rubber, or hermetically sealed compressed fiberglass.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.2 SEISMIC-RESTRAINT DEVICES:

- A. 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. Amber/Booth Company, Inc.
 2. California Dynamics Corporation.
 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 4. Hilti Inc.
- B. General Requirements for Restraint Components: Rated strengths, features, and application requirements shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Restraint Cables: ASTM A 603 galvanized-steel cables with end connections made of steel assemblies with thimbles, brackets, swivels, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Do not weld stiffeners to rods.
- F. Bushings for Floor-Mounted Equipment Anchor: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchors and studs.
- G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices.
- H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- I. Mechanical Anchor: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchors with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.
- J. Adhesive Anchor: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES:

- A. Finish: Manufacturer's standard 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 galvanized metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS:

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION:

- A. Equipment and Hanger Restraints:
 - 1. Install restrained isolators on electrical equipment.
 - 2. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

D. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. 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 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION:

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL:

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Engineer, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Engineer's approval before transmitting test loads to structure. Provide temporary load-spreading members.

4. Test at least four of each type and size of installed anchors and fasteners selected by Engineer.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.
7. Measure isolator deflection.
8. Verify snubber minimum clearances.
9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.6 ADJUSTING:

A. Adjust isolators after isolated equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 ELECTRICAL SEISMIC-RESTRAINT DEVICE SCHEDULE:

A. Supported or Suspended Equipment: Panelboards and Instrumentation Cabinets

1. Equipment Location: Various.
2. Type: As required
3. Component Importance Factor: 1.5.
4. Component Response Modification Factor: 6.0.
5. Component Amplification Factor: 2.5.

B. Supported or Suspended Equipment: Lighting and other Electrical Components

1. Equipment Location: Various.
2. Type: As required
3. Component Importance Factor: 1.5.
4. Component Response Modification Factor: 1.5.
5. Component Amplification Factor: 1.0.

END OF SECTION 260548

SECTION 260553 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.2 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each electrical identification product indicated.
- C. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels.

1.3 QUALITY ASSURANCE:

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

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS:

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color: Black letters on orange field.
 - 2. Legend: Indicates voltage and service.
- B. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

- C. Wrap Around Cable Markers: Black, non-smear legends on white background with plastic coated cloth material which remains flexible. Strong adhesive shall assure firm bond on wire.

2.2 NAMEPLATES AND SIGNS:

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
 - 1. Engraved legend with white letters on black face.
 - 2. Punched or drilled for mechanical fasteners.
- C. Exterior, reverse engraved and double laminated: Weather-resistant, nonfading, preprinted with colors, legend, and size required for the application.
- D. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS:

- A. Cable Ties: UL Listed, Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength: 18 lb minimum.
 - 3. Temperature: 85 deg C.
 - 4. Color: Natural.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract or with those required by codes and standards. Use consistent designations throughout Project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

- D. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 25-foot maximum intervals in straight runs, and at 10-foot maximum intervals in congested areas.
 3. Apply the following colors to the systems listed below:
 - a. Fire Alarm System: Red.
 - b. Telecommunication: Green and yellow.
- E. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.
1. Color-code 208/120-V(Three Phase) feeders as follows:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Ground: Green.
- F. Apply identification to conductors as follows:
1. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with circuit number.
 2. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- G. Apply identification to junction boxes including voltage, circuit number, and phase of enclosed circuits.
- H. Apply warning, caution, and instruction signs as follows:
1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation.
 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

- I. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch- high lettering on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
 - 1. Panelboards, electrical cabinets, and enclosures.
 - 2. Access doors and panels for concealed electrical items.
 - 3. Emergency system boxes and enclosures.
 - 4. Disconnect switches.
 - 5. Enclosed circuit breakers.
 - 6. Motor starters.
 - 7. Push-button stations.
 - 8. Contactors.
 - 9. Control devices.
 - 10. Power-generating units.
 - 11. Telecommunications equipment.
 - 12. Fire alarm system.
 - 13. Main disconnect.

- J. Each disconnect means shall be legibly marked to indicate its purpose. The marking shall be of sufficient durability to withstand the environment involved.

- K. Exterior, reverse engraved and double laminated: Weather-resistant, nonfading, preprinted with colors, legend, and size required for the application. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
 - 1. Mechanical / electrical equipment located outside.

END OF SECTION 260553

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes the following lighting control devices:
 - 1. Dimmer switches.
 - 2. Occupancy sensors.
 - 3. Photo sensors.
 - 4. Relay control panels with I/O devices.
- B. Related CSI Sections include the following:
 - 1. Division 26 Section 262726, "Wiring Devices" for wall manual light switches.
 - 2. Division 26 Section 265119, "LED Interior Lighting".
 - 3. Division 26 Section 265219, "Emergency and Exit Lighting".

1.2 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Include dimensions and data on features, components, and ratings for lighting control devices.
 - 1. Include name, address, and telephone number of in-state supplier of spare parts. No out-of-state suppliers shall be permitted.
- C. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Interconnection diagrams showing field-installed wiring.
- D. Field quality-control test reports.
- E. Maintenance Data: For lighting control devices to include in maintenance manuals specified in Form 817 Article 1.20 – 1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – OPERATION AND MAINTENANCE MANUALS.

1.3 QUALITY ASSURANCE:

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use and installation conditions by a testing agency acceptable to authorities having jurisdiction.
- B. Obtain lighting control devices from a single source with total responsibility for compatibility of lighting control system components specified in this Section.
- C. Comply with NFPA 70.

1.4 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.

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. Dimmer switches, Occupancy/Vacancy sensors, Photo sensors, Relay Control panels with I/O devices:
 - a. Siemens Energy and Automation, Inc..
 - b. WattStopper - Legrand.
 - c. Cooper Controls - EATON.
 - d. Leviton.
 - e. Hubbel.

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS:

- A. Interior Lighting Systems: Each space enclosed by walls or ceiling height partitions must be provided with a minimum of one control point. In addition one control is required for each task location (within an area of 450 sq.ft.). These controls must be capable of turning off all the lights within that space.
- B. All lighting systems must have some means of control, except for emergency, night lighting and exit lighting. Acceptable means of control include manual switches, photo sensors and occupancy/vacancy sensors.

- C. Line-Voltage Surge Protection: Include in all 120- and 277-V solid-state equipment. Comply with UL 1449 and with ANSI C62.41 for Category A locations.

2.3 DIMMER SWITCHES:

- A. Description: Digital or slide, white, on a single gang box. LED dimmer or 0-10VDC or compatible with dimmable load.

2.4 OCCUPANCY SENSORS:

- A. Description: Mutli-techonolgy (infrared/ultrasonic) occupancy sensors shall be installed in locations as shown on plans.
- B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.
 - 1. Corridor operation: Turn lights on along the corridor and adjacent corridors when covered area is occupied and off when unoccupied; with a 20 minute time delay for turning lights off.
 - 2. Closed room operation: Turn lights off automatically when covered area becomes unoccupied; with a 20 minute time delay for turning lights off.
 - 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit (power pack) unless connected directly to relay panel.
 - 4. Relay Unit: Dry contacts rated for 20-A load at 120VAC and 277VAC, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
 - 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
- C. One power pack is required for each controlled circuit.
- D. Wall mounted occupancy/vacancy sensors shall be line voltage with automatic off function. Device shall be set for 20 minutes delay off after occupancy.

2.5 PHOTO SENSORS:

- A. Description: Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx).
- B. Operation: Automatically lower lighting in area of coverage to the following levels when selected and calibrated lighting threshold levels are present from natural light.
 - 1. 70% of full lighting in the area of coverage.
 - 2. 40% of full lighting in the area of coverage.
 - 3. 0% of full lighting in the area of coverage.

2.6 RELAY CONTROL PANELS WITH I/O DEVICES:

- A. Description: (3) 20A rated relay control panels with (3) 0-10VDC dimming outputs installed in locations as shown on plans.
- B. General Description:
 - 1. Closed room operation: Turn lights on manually via multi-button wall station and turn lights off automatically when covered area becomes unoccupied; with a 20 minute time delay for turning lights off.
 - 2. External wall station as per the drawings:
 - a. 3-buttons for 100% lighting, 50% lighting, 0% lighting in a single gang box enclosure.
 - b. (3) Individual digital raise/low momentary switches in a 3-gang box enclosure for 0-100% light level per each zone.
 - 3. I/O Sensors: Occupancy/vacancy and photo sensors compatible with relay panel.
 - 4. I/O Module: Interface module for 3rd party communication with audio/visual system (Crestron).
 - 5. I/O Module: Occupancy status 20A rated relay for HVAC VAV control.
 - 6. Mounting: Ceiling or wall above A.C.T.
Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION:

- A. Install equipment level and plumb and according to manufacturer's written instructions.
- B. Mount lighting control devices according to manufacturer's written instructions and requirements in CSI Division 26 Section 260529, "Hangers and Supports for Electrical Systems".
- C. Control Accessibility: Lighting controls must be within the room and readily accessible. This means visible and easily operated by the occupants of the space.
- D. Minimum number of controls: At least one control must be provided for each 1500 watts of connected lighting within office core area.
- E. Mounting heights shall be as indicated on the plans.
- F. Ultrasonic and Multi-technology (Infrared-ultrasonic) ceiling occupancy sensors shall be installed at least 6 ft. away from HVAC supply/return vents.
- G. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 WIRING INSTALLATION:

- A. Wiring Method: Comply with CSI Division 26 Section 260519, "Low-Voltage Electrical Power Conductors and Cables." and CSI Division 26 Section 260533, "Raceway and Boxes for Electrical Systems".
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Ground equipment.

3.3 IDENTIFICATION:

- A. Identify components and power and control wiring according to CSI Division 26 Section 260533, "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

3.4 FIELD QUALITY CONTROL:

- A. Schedule visual and mechanical inspections and electrical tests with a least seven calendar days' advance.
- B. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:
 - 1. Continuity tests of circuits.
 - 2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions. Note: Due to room conditions it may be necessary for the Contractor to make adjustments, change the location or type of sensor to obtain proper operation and coverage of the system in each room and should therefore make labor allowance for such changes and adjustments.
 - a. Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
- C. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
- D. Lighting control devices that fail tests and inspections are defective work.
- E. Test labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- F. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.5 COMMISSIONING:

- A. Schedule a minimum of (3) site visits from the lighting controls vendor during and after system install:

1. Site visit during construction to oversee correct wiring installation per manufacturers diagrams.
2. Site visit for system programing including control panel programming, sensor setting, sensor calibration, wall station setting and other specific procedures during commissioning.
3. Site visit after move-in for end-user requested setting adjustments.

3.6 CLEANING:

- A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damage finishes.

END OF SECTION 260923

SECTION 262415 – STATIC UNINTERRUPTIBLE POWER SUPPLY AND WALL MAINTENANCE BYPASS SWITCH

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification describes a three-phase continuous duty, on-line, double conversion, solid-state uninterruptible power system, hereafter referred to as the UPS. The UPS shall operate in conjunction with the existing building electrical system to provide power conditioning, back-up and distribution for critical electrical loads. The UPS shall consist of, as required by the project, the UPS module, batteries, or other DC storage systems, and accessory cabinet(s) for transformers, maintenance bypass, and distribution applications, and other features as described in this specification.

1.2 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For all materials.
- C. Operation and Maintenance Manuals: Submit the following in accordance with Form 817 Article 1.20-1.08.14 subsection 2 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.
 - (1) UPS description
 - (2) UPS site planning and unpacking
 - (3) UPS installation
 - (4) Optional accessory installation
 - (5) UPS theory of operation
 - (6) Operating procedures
 - (7) System events
 - (8) UPS maintenance
 - (9) Performance and technical specifications
 - (10) Wiring requirements and recommendations
 - (11) Physical features and requirements
 - (12) Cabinet dimensions
- D. Warranty: Special warranties identified in Part. 1.3.

1.3 WARRANTIES

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – WARRANTIES for additional information.
- B. One-year service protection package shall include 7x24 on-site repair/replacement labor support including for UPS parts and batteries, technical support coverage, and remote monitoring service (with monthly reports for UPS and battery performance). Standard response time shall be 8 hours from receipt of call.
- C. Additional preventive maintenance visits shall be available as an option for both UPS and battery components.

1.3 UPS SYSTEM DESCRIPTION

- A. UPS System Components: The UPS system shall consist of the following main components:
 - 1. UPS module containing Rectifier(s), Inverter(s), Battery Charger(s), Static Bypass, and associated Control and Monitor Panel.
 - 2. Battery string(s) in Line-and-Match Battery Cabinets.
 - 3. Line-and-Match and/or sidecar-type accessory cabinets for transformer, parallel tie and distribution applications. Specific accessory availability depends on UPS model.
 - 4. Non-matching wall mounted or floor standing maintenance bypass cabinets or multi-module parallel tie cabinets.
- B. UPS Module Modes of Operation: The UPS Module shall operate as an on-line, fully automatic system in the following modes:
 - 1. Normal: Utilizing commercial AC power, the critical load shall be continuously supplied by the Inverter. The Inverter shall power the load while regulating both voltage and frequency. The Rectifier shall derive power from the commercial AC source and shall supply DC power to the Inverter. Simultaneously, the Battery Charger shall charge the battery.
 - 2. Battery: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source. The UPS shall be capable of operating with 432V or 480VDC battery systems.
 - 3. Recharge: Upon restoration of the AC source, the Charger shall recharge the batteries and simultaneously the Rectifier shall provide power to the

Inverter. This shall be an automatic function and shall cause no interruption to the critical load.

4. Bypass: If the UPS module must be taken out of the Normal mode for overload, load fault, or internal failures, the static bypass switch shall automatically transfer the critical load to the commercial AC power. Return from Bypass mode to Normal mode of operation shall be automatic. No-break transfer to and from Bypass mode shall be capable of being initiated manually from the front panel.

1.4 REFERENCES

- A. UL 1778 (Underwriters Laboratories) – Standard for Uninterruptible Power Supply Equipment. Product safety requirements for the United States, 4th Edition.
- B. CSA C22.2 No 107.1(Canadian Standards Association) – Commercial and Industrial Power Supplies. Product safety requirements for Canada.
- C. NEMA PE-1 – (National Electrical Manufacturers Association) – Uninterruptible Power Systems standard.
- D. IEC 62040-2 C3
- E. IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.
- F. IEEE 587 (ANSI C62.41) Category A & B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.
- G. CISPR 22 and 24, FCC Rules and Regulations 47, Part 15, Class A (Federal Communications Commission) – Radio Frequency Devices.

1.5 QUALIFICATIONS

- A. The UPS manufacturer shall have a minimum of 10 years' experience in the design, manufacture and testing of solid-state UPS systems. A list of installed UPS systems of the same type as the manufacturer proposes to furnish for this application shall be supplied upon request.
- B. The UPS manufacturer shall have ISO 9001 certification for engineering/R&D, manufacturing facilities and service organization.
- C. The UPS manufacturer shall maintain a staffed 7x24x365 call center for technical and emergency support.
- D. Field Engineering Support: The UPS manufacturer shall directly employ a nationwide field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours. A map of the United States showing the location of all

field service offices shall be submitted with the proposal. Third-party service or maintenance will not be accepted.

- E. Spare Parts Support: Parts supplies shall be located in the field to provide 80% of all emergency needs. The factory shall serve as the central stocking facility where a dedicated supply of all parts shall be available within 24 hours.
- F. Product Enhancement Program: The UPS manufacturer shall make available feature upgrade service offerings to all users as they are developed. These upgrades shall be available as optional field-installable kits.
- G. Maintenance Contracts: A complete range of preventative and corrective maintenance contracts shall be provided and offered with the proposal. Under these contracts, the manufacturer shall maintain the user's equipment to the latest factory revisions.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. The UPS shall withstand any combination of the following external environmental conditions without operational degradation.
 - 1. Operating Temperature: 5 degrees C to + 40 degrees C (41 degrees F to 104 degrees F) without de-rating (excluding batteries).
 - 2. Storage Temperature: - 25 degrees C to + 55 degrees C (-13 degrees F to 131 degrees F). Prolonged storage above + 40 degrees C (104 degrees F) will cause rapid self-discharge and permanent damage to the battery.
 - 3. Relative Humidity (operating and storage): 5-95% non-condensing.
 - 4. There shall be at least a 1.8⁰F (1.0⁰C) difference between the dry bulb temperature and the wet bulb temperature, at all times, to maintain a non-condensing environment
 - 5. The maximum rate of temperature change shall be limited to 3⁰F over 5 minutes (36⁰F/hour), based on the ASHRAE Standard 90.1-2013
 - 6. Elevation:
 - a) Operational: 5000 ft. (1500 m) maximum without de-rating. Above this rating, altitude de-rating as per IEC 62040-3
 - b) Transportation: Capable of air transport, up to 15,000m.

1.7 SAFETY

- A. The UPS shall be certified in accordance with UL 1778, 4th Edition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Approved Manufacturers: Eaton, or an approved equal.

2.2 UPS MODULE STANDARD FEATURES

The UPS module shall consist of the following standard components, housed in a 100kW frame:

- A. Quantity 2 identical 50kW UPM Universal Power Modules, each containing:
1. Rectifier/Charger: The rectifier/charger shall convert incoming AC power to regulated DC output for supplying the inverter and for charging the battery. The rectifier/charger shall be a high-frequency PWM design, using Insulated Gate Bi-polar Transistors (IGBTs). The modular design of the UPS shall permit safe and fast removal and replacement of the rectifier/charger module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode. The rectifier/charger module shall also provide the following:
 2. The rectifier shall be capable of drawing power from the utility with a power factor of 0.99 under nominal conditions.
 3. The rectifier shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
 4. Inverter: The inverter shall feature an IGBT pulse-width-modulation (PWM) design with high speed switching. The inverter shall also have the following features:
 5. The inverter shall be capable of providing the specified quality output power while operating from any DC source voltage (rectifier or battery) within the specified DC operating range.
 6. The modular design of the UPS shall permit safe and fast removal and replacement of the power module, while in maintenance bypass. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode.
 7. The inverter shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
- B. Static Bypass: The bypass shall serve as an alternative source of power for the critical load when an abnormal condition prevents operation in normal mode. The bypass for 100kW frames shall consist of a fully rated, continuous duty, naturally

commutated static switch for high-speed transfers. The bypass shall feature the following transfer and operational characteristics.

1. Transfers to bypass (for stand alone, and parallel capacity systems) shall be automatically initiated for the following conditions:
 - a) Output overload period expired.
 - b) Critical bus voltage out of limits.
 - c) Internal over temperature period expired.
 - d) Total battery discharge.
 - e) UPS failure.
 2. Uninterrupted automatic re-transfer shall take place whenever the inverter(s) is capable of assuming the critical load.
 3. Uninterrupted automatic re-transfers shall be inhibited for the following conditions:
 - a) When transfer to bypass is activated manually or remotely.
 - b) In the event of multiple transfers/re-transfer operations the control circuitry shall limit “cycling” to three (3) operations in any ten-minute period. The third transfer shall lock the critical load on the bypass source, for 60 minutes.
 - c) UPS failure.
 4. Uninterrupted manual transfers shall be initiated from the control panel. Uninterrupted manual transfers to bypass and from bypass shall be possible with the inverter logic. During manual transfers to bypass mode, the inverter must verify proper bypass operations before transferring the critical load to the bypass.
 5. All transfers to bypass shall be inhibited for the following conditions:
 - a) Bypass voltage out of limits (+10%, to -10% of nominal)
 - b) Bypass frequency out of limits (+/- 4 Hz, adjustable, factory set)
 - c) Bypass out of synchronization
 - d) Bypass phase rotation / installation error
 6. Static transfer time: No break, complete in less than 4ms.
 7. The bypass shall be manually energized using the control panel or remotely through a building alarm input.
- C. Monitoring and control components: The following components shall provide monitor and control capability:
1. Control panel: color LCD, touch sensitive, with LED status indicators.

2. Alarm and metering display.
 3. Building alarm monitoring.
 4. Communication ports: RS-232 and USB.
- D. Battery management system: The UPS shall contain a battery management system which has the following features:
1. The battery management system shall provide battery time remaining while operating in normal mode and battery mode. Battery time available information shall be displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information shall be available.
 2. The battery management system shall automatically test the battery system to ensure that the battery is capable of providing greater than 80% of its rated capacity. Testing the batteries shall not jeopardize the operation of the critical load. Upon detection of the battery string(s) not capable of providing 80%, the UPS system will alarm that the battery needs attention/replacement. The battery test shall be able to detect the following:
 - Open battery string
 - Shorted battery string (current limit)
 - Battery capacity (runtime) less than 80% of “new” battery capacity
- E. Wiring Terminals: The UPS 100kW frame modules shall contain mechanical compression terminals (adequately sized to accommodate 75 degree C wiring).
1. Rectifier/charger input connections (3-wire plus ground, or 4-wire plus ground for 4-wire models)
 2. Bypass input connections, (for dual source configurations): 3-wire plus ground for 3-wire plus ground output configuration (480Vac), or 4-wire plus ground for 4-wire plus ground output configuration (480/277Vac)
 3. DC link connections for battery cabinets (positive and negative plus ground).
 4. AC output connections (3 wires plus ground, or 4-wire plus ground for 4-wire models), 4 wire plus ground if distribution accessory cabinet with transformer is utilized.

2.3 UPS MODULE OPTIONS AND ACCESSORIES

The UPS system shall include the following options and accessories:

- A. Maintenance Bypass, Distribution, Accessory Cabinet shall be provided that include:
1. All hardware and interconnecting cable for connection to UPS module.

2. Bypass

Non-matching wall mounted maintenance bypass cabinet.

- a) Three-breaker manual maintenance bypass switch in a remote bypass panel, to isolate UPS module from commercial AC input and critical load. Switch shall provide complete isolation of UPS for servicing. Switch shall be make-before-break, interlocked between UPS and bypass to prohibit improper operation.

3. Distribution cabinet (Intergrated Line-and-match): This shall be positioned on either side of the UPS module, and shall include a K-13 rated output isolation and step down transformer. The transformer shall meet TP-1 specifications.

- a) The 100kW shall house five (5) distribution circuit breakers.

B. Network Adapter and UPS Power Monitoring Software: PX Gateway card adapter shall provide a communications interface between the UPS module and the following network management systems.

1. SNMP v.1, v.3
2. Modbus TCP
3. BACnet/WS or /IP
4. IPv6

This capability shall allow the unit to be monitored remotely over an Ethernet network using a standard web browser.

C. Relay Card: Serial dry contact card providing 4 isolated dry output contacts, 1 isolated input. The relays are programmable.

D. External Battery Cabinet: The battery cabinet shall feature valve regulated, high-rate discharge, lead-acid batteries which provide energy to the support the critical load during a momentary loss of input power to the rectifier. The batteries shall be flame retardant in accordance with UL 94V2 requirements. The battery cabinet shall have the following features:

1. The battery cabinet shall be the same depth and height as the UPS module.
2. The battery cabinet shall feature a mechanical enclosure of like appearance to the UPS module and shall feature casters for easy installation. Each battery cabinet shall require front access only for installation, service and maintenance. The battery cabinet shall provide bottom cable entry standard and top entry capability via sidecar.
3. Power wiring internal to battery cabinet shall be factory provided. Each battery cabinet shall feature up to 10 battery trays which can be individually disconnected from the battery cabinet power wiring with quick disconnect devices. Each battery tray shall be firmly secured to the

battery cabinet frame with fasteners. Each battery tray shall be removable from the front of the battery cabinet.

4. The battery cabinet shall feature a DC rated circuit breaker. The circuit breaker within the battery cabinet shall only provide protection to the battery string(s) within that battery cabinet. For battery configurations involving multiple battery cabinets, the batteries in one battery cabinet may be isolated from the DC link via its circuit breaker without disconnecting other battery cabinets from the DC link and the UPS module.
5. The circuit breaker in battery cabinet shall feature an A/B auxiliary switch. The UPS module shall be capable of monitoring and alarming an open battery cabinet circuit breaker condition.
6. The circuit breaker in battery cabinet shall feature a 48VDC shunt trip device. The shunt trip shall operate to trip the battery breaker(s) for an emergency power off command or battery disable command.
7. Power and Control wiring between the co-located battery cabinet and the UPS shall be factory provided.
8. The batteries shall be configured with a ¼” spade type connector for attaching sense leads to each jar to facilitate the future addition of a battery monitoring system.
9. Expected battery life: 200 complete full load discharge cycles when operated and maintained within specifications.

E. Remote UPS Status Indicating panel for the following indications:

1. **NORMAL:** This green LED shall indicate that the commercial AC utility or generator source is supplying power to the rectifier and the inverter is supporting the critical load.
2. **BYPASS:** This amber LED shall indicate that the UPS has transferred the load to the bypass circuit.
3. **BATTERY:** This amber LED shall indicate that the commercial AC utility or generator source has failed and the battery is supplying power to the inverter, which is supporting the load.
4. **ALARM:** This red LED and the accompanying audible alarm horn, shall indicate that the UPS detects an alarm condition, outlined in detail in the Logs tab from the home screen and in the operator’s manual.

2.4 UNINTERRUPTIBLE POWER SUPPLY RATINGS AND OPERATING CHARACTERISTICS*

- A. UPS Continuous Ratings. The UPS shall be rated:

UPS Rating (max)
100 kW

Units shall be upgraded to their maximum UPS frame rating when sufficient UPMs are installed and appropriate firmware settings are implemented.

UPS Rating (max) is the maximum output possible from the UPS (for a load power factor range of 0.8 lagging to 0.8 leading). The UPS shall not require de-rating when supporting a leading power factor load of 0.8 or greater.

It is recommended that premises wiring should be sized for the maximum possible rating of the UPS (i.e. to match the UPS frame rating).

- B. Acceptable UPS input sources:

1. 3-wire model UPS shall support 3-wire grounded Wye sources. A neutral conductor is not used from the source, and is not supplied to the load
 - a) Single source, single or dual feed: 3-wire grounded neutral wye
 - b) Dual source, dual feed: 3-wire grounded neutral wye

*TT sources for the UPS must all share the same ground plane.

2. 4-wire model UPS shall support 4-wire grounded Wye sources. A neutral conductor is used from the source and is supplied to the load.
Rectifier/charger input:
 - a. Nominal three phase input voltage: 480 Vac or 480/277Vac for 4-wire models 3-wire plus ground for 3-wire plus ground output configuration or 4-wire plus ground for 4-wire plus ground output configuration
3. Operating input voltage range: +10%, -15% of average nominal input voltage without battery discharge. Note the UPS shall “power share” with the battery to -30% of nominal voltage, at full rated load.
4. Operating input frequency range shall be 40 to 72Hz.
5. Input power factor 0.99 lagging at rated load.
6. Normal input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode:
 - a. Rectifier/charger input current limit shall be adjustable from 100 to 115% of UPS kW rating.

- b. Battery input current limit shall be adjustable from 0 to 16.5A per 50 kW UPM module. This limit may be extended to 29.3A for loads less than 80%.
7. On generator input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode on generator:
 - a. Rectifier/charger input current limit shall be adjustable from 100% to 115% of UPS full load kW rating.
 - b. Battery recharge input current limit shall be adjustable from 0 to 16.5A per 50kW UPM module. This limit may be extended to 29.3A for loads less than 80%..
8. Input current total harmonic distortion (THD) shall be less than 3% at nominal line voltage and 5% nominal source impedance.
9. Power walk-in: Ramp-up to full utility load adjustable from 10 amps per second to 1 amp per second.

C. Bypass input:

1. Synchronizing bypass voltage range shall be +10, -15% of average nominal input voltage.
2. Synchronizing bypass frequency range is +/- 0.5 Hz to +/-4 Hz, user adjustable, and is centered on the nominal frequency. Default setting is +/- 4 Hz.
3. Slew rate: 0.8 Hz per second, maximum.
4. Bypass and rectifier inputs can be supplied from out of phase sources if required.
5. Input surge withstand capability: The UPS shall be in compliance with IEEE 587 (ANSI C62.41), category A & B (6kV).

D. Rectifier/charger output:

1. Nominal DC voltage shall be 432 or 480 VDC (open circuit battery voltage). For 4-wire models, nominal DC voltage shall be 480 VDC (open circuit battery voltage).
2. Capacity: The rectifier/charger shall support a fully loaded inverter and recharge the battery to 90% of its full capacity within 10 times the discharge when input current limit is set at maximum.
3. Low line operation: The rectifier/charger shall be capable of sharing the DC load with the battery when the input voltage falls below the specified

operation input voltage range, the “on battery” indicator shall annunciate operation in this mode.

4. DC sensing: DC voltage sensing methods shall be incorporated for providing battery over-voltage protection.
5. Battery charger characteristics: The UPS battery charging system shall have the following characteristics:
 - a) The charger shall be capable of being configured for several charge modes including:
 - (1) A charging mode that increases battery life by allowing the battery to rest, reducing positive plate corrosion
 - (2) A charging mode floating the battery at a set level, which can be adjusted via software.
 - b) UPS module will automatically adjust battery shutdown based upon loading and battery capacity.
 - (1) The UPS module shall automatically adjust the final discharge voltage between 1.67 and 1.75 Volts per cell based on the existing load and the rate and length of discharge.
 - (2) The absolute minimum operational voltage is 1.67 V per cell (adjustable upward).

E. UPS output in normal mode

1. For 3-wire models, nominal output voltage 480V, 3-phase, 3-wire plus ground at the UPS output terminals, or 4 wire plus ground at the output of the IAC-D cabinet with 208V output transformer. Output wiring configuration is based upon input wiring configuration for systems without transformers. For 4-wire models, nominal output voltage 480/277V, 3-phase, 4-wire plus ground at the UPS output terminals.
2. Steady-state voltage regulation (in inverter) shall be within +/- <1% average from nominal output voltage.
3. Transient voltage response shall be per EN62040-3, Class 1, VFI-SS-111.
4. Transient voltage recovery shall be compliant to EN62040-3, Class 1, VFI-SS-111.
5. Linear load harmonic distortion capability: Output voltage THD of less than 1% for 100% linear load.

6. Non-linear load harmonic distortion capability: Output voltage THD of less than 5% for 100% non-linear load when tested using the non-linear load described in IEC 62040-3.
7. Line synchronization range shall be +/- 4Hz, adjustable to +/-0.5 Hz.
8. Frequency regulation shall be +/- 0.1Hz free running.
9. Frequency slew rate shall be 0.8 Hz/second maximum (adjustable).
10. Phase angle control:
 - a) Balanced linear load shall be <1 degree from nominal 120 degrees
11. Phase voltage control:
 - a) Balanced linear loads shall be +/- 1% from average phase voltage
 - b) Unbalanced linear loads shall be less than <2% from average phase voltage for 100% load unbalanced
12. Overload current capability (with nominal line and fully charged battery, non-paralleled systems):
 - a) Double Conversion mode: The unit shall maintain voltage regulation for 102% to <110% of resistive/inductive load for 10 minutes, 111% to <125% for 60 seconds, and 126% to 150% for 10 seconds, >151% for 300ms.
 - b) Stored energy mode (typically on battery): The unit shall maintain voltage regulation for 102% to <110% of resistive/inductive load for 10 minutes, 111% to <125% for 60 seconds, and >126% for 300ms
 - c) On bypass (single UPS systems): Continuous = 125%. Transient = 1000% peak current for 10ms.
13. Fault clearing current capability: See section 12 above.
14. Static transfer time, inverter to bypass: No break, completed in less than 4ms.
15. Static transfer time, Energy Saver to inverter: No break, completed in less than 4ms maximum, typically <2ms.
16. Common mode noise attenuation:
 - a) -65dB up to 20kHz, -40db up to 100kHz
 - b) > 100dB with isolation transformer
17. Acoustical noise: Noise generated by the UPS under normal operation shall not exceed 65dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load, per ISO 7779 standard.
18. EMI Suppression: The UPS shall meet FCC rules and regulation 47, part 15, for Class A devices, CISPR22, and IEC62040-2 C2 and C3.

19. Electrostatic discharge (ESD): The UPS shall meet IEC61000-4-2 level 3; 4kV contact/8kV air discharge.
20. Efficiency: The UPS incorporate 3-level power converter design for highest possible efficiency. Full load efficiency for non-derated hardware shall be up to 97%, 50% load efficiency shall be 96.5%, and the UPS shall achieve >95.0% efficiency at 25% load (94% at 25% load, for 4-wire version). These numbers are for N+0 configurations only.

2.5 MECHANICAL DESIGN

- A. Enclosures: The UPS shall be housed in free-standing double front enclosures (safety shields behind doors) equipped with casters and leveling feet. The enclosures shall be designed for computer room applications. Front doors shall have locks to prevent unauthorized entry.
- B. Modular construction: The UPS shall be comprised of Universal Power Modules (UPMs), each hardware-rated for 50kW, and each including the rectifier, inverter, and battery converter power and control circuitry. These UPMs shall be draw-out assemblies that can be quickly exchanged or replaced as necessary.
- C. Ventilation: The UPS and shall be designed for forced-air cooling. Air inlets shall be on the front of the unit. Air outlet configuration for the UPS, and its accessory cabinet(s) shall be user selectable at time of order to exhaust warm air at the top of the cabinet (row or wall installations). Eighteen inches of clearance over the UPS outlets shall be required for proper air circulation (top exhaust). An air filter shall be mounted in the front door of the UPS module.
- D. No back or side clearance or access shall be required for the system. The back and side enclosure covers shall be capable of being located directly adjacent to a wall.
- E. Cable entry: Standard cable entry for the 100 kW frame UPS cabinet shall be through the enclosure bottom. Top cable entry shall be facilitated by a sidecar which can be mounted on either side of the 100kW frame UPS. Standard cable entry for the 200kW frame UPSs shall be through the enclosure top or bottom.
- F. Front access: All serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS (front access only required). Side or rear access for installation, service, repair or maintenance of the UPS system shall not be required.
- G. Service area requirements: The system shall require no more than thirty six (36) inches of front service access room and shall not require side or rear access for service or installation.

2.6 CONTROLS AND INDICATORS

- B. Microprocessor controlled circuitry: The UPS controls shall have the following design and operating characteristics:
1. Fully automatic operation of the UPS shall be provided through the use of microprocessor controlled Digital Signal Processing. Start-up and transfers shall be automatic functions, and will not require operator intervention.
- C. Digital Front Panel Display: The UPS control panel shall be a 7" touch sensitive, backlit LCD front panel display that includes LED indicators for basic UPS status. Large, luminous, color coded LED pillars (vertical bars) shall show the UPS status (green, amber, red), and be visible up to 30m from the UPS. The LCD shall display:
1. UPS status (home screen): the LCD screen shall have a color coded border (header) that turns red on alarm, and shows basic UPS status in the header of the display, visible at all times. The header shall alternately show UPS status output voltage and battery time remaining, and be visible constantly in all display screens. The home screen shall show load level, average efficiency, and power consumption in kWh. The home screen shall show a system mimic diagram with a color-highlighted power path, operating mode, and active events.
 2. Controls tab: Shall provide touch sensitive button controls, with a confirm prompt, for turning the UPS on and off, transfer to/from bypass, and enabling or disabling the battery charger, initiating a battery test, and enabling or disabling Energy Saver System (ESS).
 3. Metering tab: The metering screen shall show voltages currents, temperatures, kW, kVA, and power factor (as applicable) for the UPS input, output, bypass source, and battery. Color coded (green, amber, red) bar graph indicators will accompany power and temperature measurements
 4. Logs tab: alarm/event queue, active alarms and alarm history, events, status changes and commands, all timed to the 1/1000th second for tracking and analysis.
 5. Statistics tab: Numerically and graphically displays the estimated savings afforded by ESS operation over time.
 6. Settings tab: shall provide button access to user adjustable settings such as, but not limited to: date/time, building alarm designations, communications parameter setup, UPS name, user passwords, and display language.
- D. Control Panel Lamp Indicators: The UPS control panel shall provide the following monitoring functions with indicator (icon) LED's:

1. NORMAL: This green LED shall indicate that the commercial AC utility or generator source is supplying power to the rectifier and the inverter is supporting the critical load.
 2. BYPASS: This amber LED shall indicate that the UPS has transferred the load to the bypass circuit.
 3. BATTERY: This amber LED shall indicate that the commercial AC utility or generator source has failed and the battery is supplying power to the inverter, which is supporting the load.
 4. ALARM: This red LED and the accompanying audible alarm horn, shall indicate that the UPS detects an alarm condition, outlined in detail in the Logs tab from the home screen and in the operator's manual.
- E. Interface panel: The UPS shall be equipped with an interface panel, located behind a protective cover, which provides the following signals and communication features in a Class 2 environment:
1. Alarm contact: A dry contact for annunciating a summary alarm shall be provided for customer use. This contact shall be Form "C" capable of supplying both N/O and N/C contacts. Contact ratings shall be 5A max at a voltage not to exceed 28VDC or 277VAC.
 2. RS232 (EIA / TIA-232) and USB communications interfaces: Circuitry shall be provided for one "host", and one "device" USB connector, and one RS232 (EIA / TIA-232) communication port for connection to automated service department diagnostic tools. This port may be used with simple ("dumb") terminals to gain remote access to all unit operation information.
 3. Building alarms: Five inputs shall be provided for monitoring the status of external dry contacts. Building alarms shall be set up through the UPS configuration mode function on the UPS front panel display or via the RS232 (EIA / TIA-232) port.
 4. External REPO contacts: Shall be provided to connect an external remote emergency power off switch to shut down the UPS and de-energize the critical load. Normally open or normally closed contacts shall be acceptable.
 5. Battery control contacts: Contacts shall be provided to connect the battery shunt trip and auxiliary contact signals from a battery breaker or battery disconnect switch.
 6. External bypass indicator connection: A connection point shall be provided to acknowledge that an external maintenance bypass has been closed around the UPS, placing the critical load on utility power.

2.7 COMMUNICATIONS

- A. Communications Bay: The UPS shall be equipped with field configurable communications bays that will accommodate four (4) plug-in communication devices
- B. Remote Monitoring:
 - 1. Optional WEB/SNMP communication capabilities will be available for all systems.
 - 2. The UPS shall be able to be monitored remotely via communications devices. UPS manufacturer shall provide optional communications devices capable of communicating via various industry standard protocols such as RS232, SNMP, BACnet and ModBus. Monitoring of UPS status may also be performed through isolated dry contact Form C relays.

The UPS communication capability should be able to integrate into any industry standard Building Management System (BMS) and/or Network Management System (NMS). The UPS must also be able to be monitored via any standard Internet browser.

All optional hardware interfaces shall be “Hot-swappable” (UPS maintains power to critical applications while changing interfaces).

- C. Shutdown:
 - 1. There shall be a mechanism that provides graceful, orderly, unattended, sequential shutdown of one or multiple computers powered by one UPS. This shutdown shall be performed via in-network or out-of-network means. The order of shutdown shall be user-defined, allowing the maximization of runtime on battery for more critical systems.
 - 2. The UPS shall also be capable of interfacing with an operating system’s built-in shutdown routine. This shall be done through a cable connection to the communication interface card.
- D. Notification:
 - 1. There shall be a mechanism to send alerts to key personnel via email or SNMP traps. An alarm notification may also be sent by a network message.

2.8 UPS MODULE PROTECTION

- A. Rectifier/Charger and Bypass protection shall be provided through individual fusing of each phase.

- B. Battery protection shall be provided by thermal-magnetic molded-case circuit breakers in each battery cabinet (if standard battery pack is provided) or external protective device for an external battery.
- C. Electronic current limiting circuitry and fuses in the Inverter circuit shall provide output protection.
- D. To comply with agency safety requirements, the UPS module shall not rely upon any disconnect devices outside of the UPS module to isolate the battery cabinet from the UPS module.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.2 COMMISSIONING

- A. Factory start-up shall be provided on a 7 x 24. Start-up service of UPS and batteries. Site Audit, installation and commissioning of monitoring service. Start-up shall include one visit to perform all procedures and tests specified within UPS Installation and Operation manual. UPS manufacturer shall also offer the following optional services:
 - 1. Pre-energize visit to inspect installation and provide guidance to installers as required.
 - 2. Post-start-up visit for alarm notification configuration, operator training, generator testing, etc.
 - 3. Manufacturer shall also offer an optional service plan to provide 7x24 on-site coverage (preventive and corrective) for UPS and batteries, guaranteed response time, remote monitoring, Web access to service site history, annual Site Audit, UPS and battery preventive maintenance visit, and discounts on upgrade and modification kits. Manufacturer shall also provide an optional battery service plan to provide parts-and-labor coverage for partial and full battery strings, either with preventive maintenance or replacement coverage.
- B. The following procedures and tests shall be performed by Field Service personnel during the UPS startup:
 - 1. Visual Inspection:
 - a) Visually inspect all equipment for signs of damage or foreign materials.

- b) Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety related factors.
2. Mechanical Inspection:
- a) Check all the power connections for tightness.
 - b) Check all the control wiring terminations and plugs for tightness or proper seating.
3. Electrical Pre-check:
- a) Check the DC bus for a possible short circuit.
 - b) Check input and Bypass power for proper voltages and phase rotation.
 - c) Check all lamp test functions.
4. Initial UPS Startup:
- a) Verify that all the alarms are in a “go” condition.
 - b) Energize the UPS module and verify the proper DC, walkup, and AC phase on.
 - c) Check the DC link holding voltage, AC output voltages, and output waveforms.
 - d) Check the final DC link voltage and Inverter AC output. Adjust if required.
 - e) Check for the proper synchronization.
 - f) Check for the voltage difference between the Inverter output and the Bypass source.
 - g) Optional on site full-load, step-load, and battery discharge tests using supplier furnished load bank, shall also be offered.

3.3 TRAINING

- A. Refer to Form 817 Article 1.20-1.08.14 subsection 3 for additional information.
- B. Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation.

END OF SECTION 262415

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes lighting and power panelboards rated 600 V and less.

1.2 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of panelboard, accessory item, and component specified.
- C. Shop Drawings: For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:
 - 1. Enclosure type with details for types other than NEMA 250, Type 1.
 - 2. Bus configuration and current ratings.
 - 3. Short-circuit current rating of panelboard.
 - 4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.
 - 5. Wiring Diagrams: Details of schematic diagram including control wiring and differentiating between manufacturer-installed and field-installed wiring.
- D. Quality Assurance Submittals:
 - 1. Qualification Data: For firms and persons specified in "Quality Assurance."
 - 2. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- E. Maintenance Data: For panelboard components to include in the operational and maintenance manuals specified in Form 817 Article 1.20 – 1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS. Include manufacturer's written instructions for testing circuit breakers.

1.3 QUALITY ASSURANCE:

- A. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the NEC, Article 100.
 - 2. Comply with NFPA 70.
 - 3. Comply with NEMA PB 1.

1.5 SPARE PARTS:

- A. Furnish to the Engineer spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: 6 spares of each type of panelboard cabinet lock.
 - 2. Accessory Set: Include tools and miscellaneous items as required for overcurrent protective device test, inspection, maintenance, and operation.

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. American Circuit Breaker Corp.
 - 2. Eaton / Cutler-Hammer.
 - 3. General Electric Co.; Electrical Distribution & Control Div.
 - 4. Siemens Energy & Automation, Inc.
 - 5. Square D Co.

2.2 PANELBOARD FABRICATION:

- A. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB 1, Type 1, unless otherwise indicated to meet environmental conditions at installed location.
- B. Directory Frame: Metal, mounted inside each panelboard door.
- C. Bus: Hard drawn copper of 98 percent conductivity.
- D. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS:

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: In panelboard front, with concealed hinges. Secure with flush catch and tumbler lock, all keyed alike.

2.4 DISTRIBUTION PANELBOARDS:

- A. Doors: In panelboard front, except omit in fusible-switch panelboard, unless otherwise indicated. Secure door with vault-type latch with tumbler lock, all keyed alike.
- B. Branch-Circuit Breakers: Where overcurrent protective devices are indicated to be circuit breakers, use bolt-on circuit breakers, except circuit breakers 225-A frame size and greater may be plug-in type where individual positive-locking device requires mechanical release for removal.

2.5 OVERCURRENT PROTECTIVE DEVICES:

- A. Molded-Case Circuit Breaker: NEMA AB 1, handle lockable.
 - 1. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting capacity rating to meet available fault current.
 - 2. Application Listing: Appropriate for application, including Type SWD for switching fluorescent lighting loads and Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
 - 4. Circuit Breakers, 400 A and Larger: Field-adjustable short-time and continuous current settings.
 - 5. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
 - 6. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
 - 7. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
 - 8. Shunt Trip: Where indicated.
- B. Fusible Switch: NEMA KS 1, Type HD, clips to accommodate specified fuses, handle lockable.

2.6 TRANSIENT VOLTAGE SURGE SUPPRESSORS:

- A. Description: IEEE C62.41, selected to meet requirements for category indicated.

1. Exposure: Low.
- B. Description: Comply with CSI Division 26 Section 264313 "Transient Voltage Suppression for Low Voltage Electrical Power Circuits," to protect unit panelboard, and having the following features:
 1. Nonlinear Loading: System shall accommodate rated-load current with a minimum of 3.0 crest factor and 85 percent total harmonic distortion.
- C. Impulse spark over voltage coordinated with system circuit voltage.
- D. Factory mounted with UL-recognized mounting device.

2.7 CONTROLLERS:

- A. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held general-purpose controller, with current rating, poles, and connections as indicated; factory mounted in indicated panelboard.
 1. Control Power Source: 120-V branch circuit as indicated.

2.8 ACCESSORY COMPONENTS AND FEATURES:

- A. Portable Test Set: Arranged to permit testing of functions of solid-state trip devices without removal from panelboard.

PART 3 - EXECUTION

A. INSTALLATION:

1. Install panelboards and accessory items according to NEMA PB 1.1.
2. Mounting Heights: Top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.
3. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.
4. Circuit Directory: Type directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing.
5. Install filler plates in unused spaces.
6. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.
7. Panelboard shall be marked to warn qualified persons of potential electric arc flash hazard, marking shall be clearly visible with the manufacturers name, trademark.
8. Parts of electric equipment that in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed and separated from all combustible material.

B. IDENTIFICATION:

1. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

C. GROUNDING:

1. Make equipment grounding connections for panelboards as specified in CSI Division 26 Section 260526, "Grounding and Bonding for Electrical Systems."

D. CONNECTIONS:

1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. FIELD QUALITY CONTROL:

1. Prepare for acceptance tests as follows:
 - a. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
 - b. Make continuity tests of each circuit.
2. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - b. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.
3. Balancing Loads: Two 2 months after issuance of the Certificate of Compliance, conduct load-balancing measurements and make circuit changes as follows:
 - a. Perform measurements during period of normal working load as advised by the Engineer.
 - b. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid

- disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
- c. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test records.
 - d. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as required to meet this minimum requirement.
4. Infrared Scanning: Two 2 months after the issuance of the Certificate of Compliance, perform an infrared scan of each panelboard. Remove fronts to make joints and connections accessible to a portable scanner.
- a. Instrument: Use an approved infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide calibration record for device used.
 - b. Record of Infrared Scanning: Prepare a certified report identifying panelboards checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. CLEANING:

1. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes the following:
 - 1. Receptacles
 - 2. Ground Fault Circuit Interrupter Receptacles
 - 3. Snap Switches
 - 4. Wall Plates
- B. Related CSI Sections include the following:
 - 1. Division 26 Section 260519 "Low-Voltage Electrical Power Conductors and Cables"

1.2 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data for receptacles, GFCI receptacles, plugs, snap switches and wall plates.

1.3 QUALITY ASSURANCE:

- A. Regulatory Requirements: Comply with provisions of the following code:
 - 1. NFPA 70 "National Electrical Code"
- B. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

1.4 SEQUENCE AND SCHEDULING:

- A. Schedule installation of finish plates after the surface upon which they are installed has received final finish.

PART 2 - PRODUCTS

2.1 WIRING DEVICES:

- A. General: Provide specification grade wiring devices, in types, characteristics, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards. Color selections are as indicated on the plans.
 - 1. General: Wiring devices include receptacles, switches and special outlets installed in raceway or conduit boxes, complete with cover plates. Devices shall conform to NEMA WD-1 and shall be UL approved.
 - 2. All devices of a given type and all finished device plates shall be the products of a single manufacturer.
 - 3. Receptacles on UPS Source Panels shall be color red. All other shall be color white.
 - 4. Isolated ground duplex receptacles shall be provided for computers and peripheral equipment.

- B. Enclosures:
 - 1. NEMA Type 1 or as indicated on plans.

- C. Switches:
 - 1. AC tumbler-toggle switches: Meeting minimum requirements of UL 20 and further requirements herein specified and of specification grade, heavy duty, of the type indicated on the Contract plans.
 - a. Provide switches that operate in any position and are fully enclosed cup type with entire body and cover of molded phenolic, urea or melamine. Do not use fiber, paper or similar insulating material for body or cover.
 - b. Equip switches with metal mounting yoke with plaster ears, insulating from the mechanism and fastened to the switch body by bolts, screws, rivets or other substantial means that meet test requirements.
 - c. Provide a green-colored equipment grounding screw on the yoke.
 - d. Provide the section of yoke normally intended to bear on the surface outside the box with a minimum overall dimension of 3/4 inch, measured at right angles to the longitudinal axis of the yoke.
 - e. Make switch contacts between silver or silver alloys.
 - f. Switches shall be back and side wired with terminal of screw or combination screw-clamp type. Provide access holes for back wiring.

- g. Wiring terminals capable of receiving and holding proper wire sizes as shown below:

<u>Switch Rating</u>	<u>Wire Size, AWG No.</u>
20 amperes	12
30 amperes	10

2. Switches for Heavy Duty: Unless specified otherwise, use standard tumble-toggle switches of the AC single unit, toggle type, heavy duty, general use snap switches in accordance with NEMA WD 1 for heavy duty general use type.
3. Switches for Use on Incandescent, Fluorescent, Metal Halide, or High Pressure Sodium Lighting Circuits: Fully rated 20 or 30 amperes at 120 or 208 volts, as indicated on the Contract Drawings. Actual connected lamp wattage not to exceed the following:

<u>Switch Rating at 120 and 208 Volts</u>	<u>Maximum Wattage Allowed</u>
20 amperes	1,400
30 amperes	2,400

4. Switches for Power Equipment: Switches controlling outlets other than lighting, such as motors less than 1/4 horsepower, may be specification grade, flush type, AC/DC contacts rated ten amperes, 125 volts. Switches controlling straight resistance loads may be snap switches as specified herein, of the proper rating up to 30 amperes at 120-208 volts. Switches used for controlling motors shall be rated for at least the horsepower of the motor controlled.
5. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
- a. Arrow-Hart Division, Crouse-Hinds Company
 - b. Bryant Electric Company
 - c. Hubbell, Inc.
 - d. General Electric
 - e. Pass and Seymour

D. Receptacles and Plugs:

1. General Use: Grounding duplex type, conforming to NEMA WD-1, configuration 5-20R. Bodies shall be of thermosetting plastic supported on a metal mounting strap. Wiring terminals shall be of the screw type, back or side wired.
2. Ground Fault Interrupter Receptacle: NEMA Designation 5-20R, duplex, two pole, three wire, 20 amperes, 125 volt, ground fault interrupter type.
3. Isolated Ground: Specification heavy-duty grade, duplex type, 120 volt, single phase, 15 amperes, two pole, three wire, grounding type NEMA Configuration 5-15R. Color orange.
4. 250 volt, single phase, 30 amperes, two pole, three wire, grounding type, NEMA Configuration 6-30R.
5. 120 volt, single phase, 20 amperes, two wire, three pole, suitable for Class 1, Division 1, hazardous location, factory sealed, heavy duty receptacle with matching plug. The unit shall be delayed action circuit breaking with release lever, Crouse-Hinds CPS with CPP plug, or approved equal.
6. Available Manufacturers: Subject to compliance with requirements, manufacturers of other devices offering products which may be incorporated in the work include, but are not limited to, the following:
 - a. Arrow-Hart Division, Crouse-Hinds Company
 - b. Square D Company
 - c. Harvey Hubbell, Inc.

E. Device Plates:

1. All device plates shall be 0.040 inch minimum with struck-up beveled edges, void of sharp corners and burrs.
2. Unless otherwise noted herein and on drawings, all device plates for wall outlets and switches shall be brush satin finish stainless steel for office areas and painted type 430 stainless steel Sierra C400 series for other areas.
3. Device plates for wall telephone outlets shall contain a bushed hole.
4. Device plates for exposed work shall be cast aluminum. Plates for wet locations shall be gasketed and shall have self-closing hinged covers.
5. Plate for floor receptacle shall be forged brass with duplex flap type openings and specifically designed for the associated floor box.
6. Hardware Screws: PVC only.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES AND ACCESSORIES:

- A. Install devices and accessories assemblies level, plumb, and square with building lines, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other Work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other Work.
- C. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.
- D. Install wall plates after painting work is completed.
- E. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486A. Use properly scaled torque indicating hand tool.
- F. Switches and Receptacles: Wall switches shall be mounted 4' above finished floor opposite hinge side of door, 4" from door trim, and ganged under one cover where more than one switch is shown. Disconnect switches shall be mounted 24" above finished floor and receptacles shall be mounted 24" above finished floor, and in office areas unless otherwise noted. All wall switches and receptacles shall be flush mounted.

3.2 PROTECTION:

- A. Protect installed components from damage. Replace damaged items prior to final acceptance.

3.3 FIELD QUALITY CONTROL:

- A. Testing: Prior to energizing circuits, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing, test wiring devices and demonstrate compliance with requirements, operating each operable device at least six times.
- B. Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.

- C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.4 CLEANING:

- A. General: Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 262726

SECTION 262727 – FLOOR BOX WIRING DEVICE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Floor boxes.

1.2 RELATED SECTIONS

- A. Division 07 Section 078413 – Penetration Firestopping.
- B. Division 26 Section 262726 – Wiring Devices.
- C. Division 27 Sections.

1.3 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For electrical floor boxes.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firms regularly engaged in manufacture of electrical floor boxes and fittings of the types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years. Provide electrical floor boxes and fittings produced by a manufacturer listed in this section.
- B. Electrical Boxes and Fittings: Comply with requirements of applicable local codes, NEC, UL, ETL, and NEMA Standards pertaining to boxes and fittings. Listed and labeled in accordance with NFPA 70, Section 300-21.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver electrical floor boxes in factory labeled packages.
- B. Store and handle in strict compliance with manufacturer's written instructions and recommendations.
- C. Protect from damage due to weather, excessive temperature, and construction operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design for electrical floor boxes and fittings is based on Evolution Series Floor Boxes manufactured by Legrand/Wiremold or an approved equal.

2.2 FLOOR BOXES

- A. Classification and Use: Floor boxes shall have been examined and tested by UL to meet UL514A and bear the U.S. UL Listing Mark. Floor boxes shall also have been tested by UL and classified for fire resistance and bear the U.S. UL Classification Mark. Devices shall be classified for use in 2-hour rated, unprotected reinforced concrete floors and 2-hour rated floors employing unprotected steel floor units and concrete toppings (D900 Series Designs) or concrete floors with suspended ceilings (fire resistive designs with suspended ceilings should have provisions for accessibility in the ceiling below the floor boxes). Floor boxes shall also conform to the standards set in Section 300-21 of the NEC. Floor boxes shall meet UL scrub water requirements, but are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids. Floor boxes shall also have been evaluated by UL to meet the applicable U.S. safety standards for scrub water exclusion when used on raised carpet covered floors. Floor boxes shall be suitable for use in air handling spaces in accordance with Section 300-22 (C) of the NEC.
- B. Floor Boxes, General: Boxes shall be compatible with complete line of Ortronics[®] workstation connectivity outlets and modular inserts.
 - 1. Floor boxes provide the interface between power, communication and audio/video (A/V) cabling in above-grade floors, on-grade concrete floors, raised floors, wood floors, and fire-classified floors and the workstation or activation location where power and communication and/or A/V device outlets are required. Boxes shall provide recessed device outlets that will not obstruct the floor area. Refer to Drawings for size and types.
 - 2. Floor boxes shall permit all wiring to be completed at floor level. The FC models shall be used as defined by the UL Fire Resistance Directory at a minimum spacing of 2 feet on center.
- C. Model EFB10S Floor Boxes: Manufactured from stamped steel approved for use on raised floors. Boxes shall have a polyester based backed enamel finished interior (white). Boxes shall be 15-3/16" L x 12-3/4" W x 6-1/16" H. Provide boxes with provisions that enable installation into raised floors without having to purchase additional components or accessories. Provide boxes with 10 independent wiring compartments that allow for up to 10 receptacles, communication and/or audio/video services. Boxes shall permit feed to adjacent compartments. Boxes shall permit feed to

compartments on the opposite side of the box through a tunnel. Six (6) of the 10 compartments shall have a minimum wiring capacity of 23-1/2-in³. Four (4) of the 10 compartments shall have a minimum wiring capacity of 27-in³. Each of the 10 compartments shall have a minimum depth of 3-1/2" behind the plate. Provide boxes with removable compartments to facilitate installation and moves, additions, and changes. The compartments shall be removable from the top and back of the floor box. Provide boxes with two (2) cable guides to organize and maintain the cables egress out of the box. Provide boxes with removable knockout plates to allow for the maximum cable pass-through area. The cable pass-through area shall be a minimum of 11-5/8 in². The box shall contain the following number of knockouts: four (4) 3/4-inch trade size, 10 1-inch trade size, eight (8) 1-1/4-inch trade size, and two (2) 2-inch trade size. Boxes shall be fully adjustable, accommodating a maximum 2-inch pre-concrete pour and a maximum 1/2" post-concrete pour adjustment. Equip boxes with toggle clamps to allow box to be secured to raised and wood floors. Include mounting brackets with the boxes that will accommodate 15 amp, 20 amp straight blade, 20 amp turn loc, 30 amp straight blade and 30 amp turn loc receptacles. Boxes shall have the ability to accommodate a bracket (EFB-50A) allowing for one (1) 50-amp receptacle. Boxes shall also accommodate Ortronics[®] workstation connectivity and modular adapters, a variety of audio/video devices from most manufacturers, and other open system devices.

2.3 ACTIVATION COVERS

- A. Evolution EFB610BT and EFB610CT Series Covers: Manufactured of die-cast aluminum. Activation covers shall be available in surface mount and flush versions. Provide covers with two (2) gaskets (one (1) for carpet and one (1) for tile) to go under the trim flange to maintain scrub watertightness. Covers shall be 16-15/16" x 12-1/2" x 3/16". Covers shall be available with a carpet recess area or a solid lid. Secure the cover to the flange and enable cover to rotate greater than 180 degrees to reduce trip hazards and provide maximum amount of working space. Provide covers with spring-loaded self-closing slide egress doors to reduce egress opening when cables are exiting and reduce trip hazards. Each of the two (2) egress openings shall have a minimum of 4-in², or a minimum of 8-in² per cover assembly. Cover finish shall be available in six (6) powder coated finishes: black, brass, nickel, bronze, gray, and aluminum. The Designer will select the finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions under which boxes and fittings are to be installed. Notify the Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.

3.3 CLEANING AND PROTECTION

- A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
- B. Protect boxes until acceptance.

END OF SECTION 262727

SECTION 262728 – TRACK BUSWAY

PART 1 - GENERAL

1.1 SUMMARY

- A. This specification covers the electrical characteristics and general requirements for a track busway system, hereafter referred to as Track Busway. The system shall be designed primarily for overhead power distribution of electrical power. Once installed, the Track Busway will provide simple, versatile, fast and economic means of distributing power. Loads fed from Track Busway plug-in units can be added or removed without shutting down the busway.
- B. Specification includes:
 - 1. Three-phase Track Busway system with the following features:
 - a. Extruded aluminum busway housing with conductors
 - b. Power Feed
 - c. Plug-in units for power distribution
 - d. Monitoring
 - e. Installation tool and joint kits

1.2 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For all materials.
- C. Shop Drawings: Include:
 - 1. Detailed equipment assemblies and dimensions, weights, location and identification of each field connection
 - 2. Wiring Connection: for power and monitoring wiring
 - 3. Orientation of plug-in units face in final installation
 - 4. Include plug-in schedule with detailed description
- D. Provide electrical characteristics and connection requirements for the system.
- E. Indicate special receiving and handling procedures.

F. Documentation

1. The following documentation shall be available to assist in product selection and installation, and is available for download at <http://downloads.uecorp.com/>:
 - a. Track Busway Product Selection Guide
 - b. Operation, Installation and Maintenance Manuals. Refer to Form 817 Article 1.20-1.08.14 subsection 2 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
 - c. Installation Instructions
2. Product drawings shall be rendered and provided with the submittals.

G. Warranty: As specified herein.

1.3 WARRANTIES

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – WARRANTIES for additional information.
- B. The Track Busway manufacturer shall warranty the entire system against defective material and workmanship for a period of 2 years from the issuance of the Certificate of Compliance.
- C. The Track Busway manufacturer shall identify any extended warranty programs (meter programming, commissioning, and support) that are available at additional costs.

1.4 STANDARDS AND CERTIFICATION

- A. The Track Busway shall be designed and manufactured to the following standards:
 1. Electrical Testing Laboratories (ETL) (US/Canada) Certified to UL 857.
 2. NEC – Article 368 – Busways
 3. NFPA – 70, NEC
 4. NEMA – AB1, Molded Case Circuit Breakers and Molded Case Switches

1.5 SYSTEM DESCRIPTION

A. Electrical Requirements

1. System voltage: up to 600V
2. Frequency: 50/60 Hz.
3. Ampacity: 100A
4. Neutral Ampacity: Minimum of 100% of rating (optional 200% for 100T3)
5. Short circuit rating must be: 22 kAIC up to 600V.
6. Conductors: 3 phase conductors, 1 neutral conductor solid copper, tin plated
7. Grounding: Aluminum casing or 1 dedicated conductor solid copper, tin plated

B. Operational Requirements

1. Environmental Conditions: The Track Busway shall be capable of operating continuously in the following environmental conditions without mechanical or electrical damage, degradation or derating of operating capability.
 - a. Operating temperature: busway shall operate with continuous load with no derating up to 60 degrees Celsius
 - b. Relative humidity: 0 to 95 percent, noncondensing
 - c. Altitude: Sea level to 4,000 feet (1220m)

PART 2 – PRODUCTS

2.1 MANUFACTURERS

1. A minimum of 10 years' experience in the manufacturing of the busway products.
2. All Track Busway components shall be manufactured by Universal Electric Corporation, or an approved equal.

2.2 PRODUCT COMPONENTS

A. Track Busway Housing

1. Extruded aluminum housing certified to serve as a 100% ground. Standard housing lengths are 5, 10 and 20 feet (1.5, 3 and 6 meters). 20 ft. (6 meter) maximum lengths can be cut in customizable lengths down to the inch or 3 centimeters. The housing should be properly extruded with a slot to receive rod mount hangers to hang from a ceiling. This housing should be open on the bottom to accept plug-in units anywhere along its length. This opening shall pass UL's hypothetical finger probe test.
2. All conductors shall be made of copper, or of copper/aluminum for 800T5 and 1200T5 systems, and sized to handle 100% of its rating continuously up to the maximum ambient temperature. The conductors shall be electrically isolated from the housing. All insulators must be UL and IEC compliant.
 - a. Ground conductor: An internal, 100% ground conductor is to be supplied if shown on the drawings
 - b. Oversized neutral: An oversized, 200% neutral conductor shall be supplied if shown on the drawings
3. Track Busway housing sections shall be joined together by a 'press fit' that requires no bolted connection and no future maintenance
4. Track Busway T5 series shall have an included data channel built into the housing to accommodate optional, color-coded data cabling accessories
5. Track Busway housing shall be available in standard silver, red, blue, black, white or custom RAL colors

B. Power Feed

1. The power feed shall provide the connections from the incoming cables to the Track Busway system. The power feed shall have internal connection to a section of busway conductors. End feeds, top feeds, center feeds and bottom feeds shall be available depending upon what Track Busway system is required. Feeds shall have the option to be designed with mechanical or compression type lugs.

C. Plug-In Units

1. Plug-in units shall be polarized to avoid incorrect installation.

2. Plug-in units can be added, removed or repositioned without de-energizing the busway.
3. Plug-in units shall use either a circuit breaker or a fuse for branch circuit protection as shown in the schedule on the project drawings.
4. Plug-in units shall be capable of being built with customer-specified circuit protection, outlets and accessories.
5. Plug-in units shall not require any tools to mount to the busway.
6. Plug-in units shall not have a mechanism in order to engage the electrical connection to the busway conductors.
7. Plug-in units shall have locking clips or bolt-on tabs to secure units to the busway.
8. Plug-in units that include drop cords shall be manufactured with cord grips and L6-30R receptacles.
9. Plug-in units shall be configured by the manufacturer to balance the load based on quantity of plug-in unit types provided.
10. Plug-in units shall have the ability to provide up to a 400 amp load in certain plug-in unit configurations.
11. Plug-in units shall have a minimum of 10kAIC and the ability to obtain a maximum of 200Kaic.
12. Plug-in units shall be interchangeable within each Track Busway series (T1, T2, T3, T5).
13. Plug-in units shall be available with optional, revenue grade metering devices.
14. Plug-in units authenticity shall be proven by the presence of a Starline (or other manufacturer) ratings label.

D. Accessories

1. Closure strip and access panels shall be available for conductor access points to minimize accidental contact or build-up of debris.
2. Integrated cable management solutions as part of the aluminum housing (T5 series), capable of handling accessories such as the data channel cover, hinged wire way, data cable strap, and multi-use mounting bracket.
 - a. Data channel covers are color-coded for integrated cable management solutions.
3. Universal Server Cabinet Mounting Brackets shall be available as an alternative hanging solution; meant for mission critical applications.

E. Monitoring

1. Power Feed Monitoring: The power feed is to be provided with the following power measurements and remote monitoring interface:
 - a. Input Voltage (L/L and L/N)
 - b. Current per Phase (Min/Max)
 - c. Voltage per Phase (Min/Max)
 - d. Neutral Current
 - e. Power Factor
 - f. Frequency
 - g. Power (Active, Reactive, Apparent)
 - h. Demand (kWH)
 - i. Current Peak Demand
 - j. Communications is Modbus RTU, Modbus TCP, Ethernet SNMP, BACnet and optional wireless
 - k. LED colored, 4.9 inch (125mm) display
2. Plug-In Unit Monitoring: The plug-in units as indicated on the schedule on the project drawings shall have the following power measurements and remote monitoring interface.
 - a. Input Voltage (L/L and L/N)
 - b. Current per Phase (Min/Max)
 - c. Voltage per Phase (Min/Max)
 - d. Power Factor
 - e. Frequency
 - f. Power (Active, Reactive, Apparent)
 - g. Demand (kWH)

- h. Current Peak Demand
- i. Accuracy is better than 0.5%
- j. Communications is Modbus RTU, Modbus TCP, Ethernet SNMP, BACnet and optional wireless plus available daisy chain Ethernet topology
- k. Display

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install Track Busway in accordance with the manufacturer's instructions.
 - 1. Track Busway runs shall consist of lengths required to power all equipment racks (Item 1108504A) in the VDTR room G303 and as shown on the contract plans. A minimum of 2 track busways connected to separate power circuits shall be installed for each row of equipment racks for a total of 6 track busways. The contractor shall coordinate installation of the track busway so not to interfere with the overhead ladder-type cable tray or fiber optic cable management system (Item 1108539A) and to ensure power is provided to each equipment rack.
 - 2. The contractor shall install 2 track busway plug-in units above each equipment rack to provide 208/120V power. The contractor shall install and secure the drop cables from the plug-in units into each equipment rack to make a connection to each rack mounted power distribution unit (PDU). The contractor shall ensure drop cable lengths are sized appropriately for connection to each rack mounted PDU. The plug-in unit orientation shall be installed as indicated on the contract plans.
 - 3. Hanging of the Busway: The contractor shall install the track busway in the VDTR room G303 by attaching to structurally supported ceiling grid using reconfigurable load connector hangers. The hangers shall connect to the busway, and to threaded rod provided by the installing contractor. The hangars or power feeds shall not protrude through the ceiling grid. The spacing of the hangers along the busway is 10 feet or as required to properly support the track busway including plug-ins and drop cables. The contractor shall coordinate with the structurally supported ceiling grid system to ensure the track busway is properly installed and supported.

4. Power feeds to each of the 6 track busways shall be installed with all necessary cable support hangers connected to the structurally supported ceiling grid back to the wall mounted sub panel. The power feeds to each track busway shall be installed below the ceiling grid and shall not enter or interfere with the ladder-type cable tray or fiber optic cable management system.
 5. The busway shall be installed with the open access channel facing downward, or to the side for special applications. Special installation shall be agreed upon by the manufacturer.
 6. Connecting Sections of Track Busway: At a junction of Track Busway sections, the installer will use a Joint Kit (includes Housing Couplers and Bus Connector) and an Installation Tool supplied by the manufacturer. Two sections are joined together by a 'press fit' that requires no bolted connection and no future maintenance.
 7. End of Runs: End caps will be provided to install at the end of each run.
 8. Closure Strip: The closure strip is an optional accessory that can be cut and fitted to cover the bottom opening of the Track Busway housing to prevent dust and debris. Closure Strip can be field modified for fit.
- B. All Track Busway joints are non-bolted, compression fit and shall require no maintenance after installation.

3.2 FIELD QUALITY CONTROL

- A. Manufacturers Field Services: Track Busway shall include on-site support and system startup and ongoing support. These services include:
- a. Installation Inspection, Commissioning and Certification
 - i. Includes comprehensive visual inspection and certified report once results are satisfactory
 - b. Load Bank Testing
 - c. IR Scanning and other Ongoing Support
 - d. 24/7 Emergency Service and Phone Support

3.3 TRAINING

- A. Refer to Form 817 Article 1.20-1.08.14 subsection 3 for additional information.
- B. Engage a factory-authorized service representative to instruct Owner's personnel in operating and routine maintenance service procedures to be used with the track busway.

END OF SECTION 262728

SECTION 262813 – FUSES

PART 1 - GENERAL

1.1 SUMMARY:

A. This Section includes the following:

1. Fuses.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. CSI Division 26 Section 262816, "Enclosed Switches and Circuit Breakers" for fusible disconnect switches.

1.2 SUBMITTALS:

A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

A. Product Data for each fuse type specified, including the following:

1. Descriptive data and time-current curves.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Coordination charts and tables and related data.

B. Field test reports indicating and interpreting test results.

D. Maintenance Data: For fuses to include in the operational and maintenance manuals specified in Form 817 Article 1.20 – 1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – OPERATION AND MAINTENANACE MANUALS.

1.3 QUALITY ASSURANCE:

A. Source Limitations: Obtain fuses from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the NEC, Article 100.

1.4 SPARE PARTS:

A. Furnish to Engineer spare parts described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents. "Refer to NOTICE TO CONTRACTOR – SPARE PARTS for additional information".

1. Spare Fuses: Furnish quantity equal to 20 percent of each fuse type and size installed, but not less than 1 set of 3 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fuses that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries, Inc.; Bussmann Div.
2. Eagle Electric Mfg. Co., Inc.
3. Ferraz Corp.
4. General Electric Co.; Wiring Devices Div.
5. Gould Shawmut.
6. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES:

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

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.
- B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS:

A. Main Service: Class L, fast acting.

- B. Main Feeders: Class J, time delay.
- C. Motor Branch Circuits: Class RK1, time delay.
- D. Other Branch Circuits: Class RK5, non-time delay.

3.3 INSTALLATION:

- A. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

3.4 IDENTIFICATION:

- A. Install labels complying with requirements for identification specified in CSI Division 26, Section 260553 "Identification for Electrical Systems" and indicate 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 SUMMARY:

- A. This Section includes individually mounted switches and circuit breakers used for the following:
 - 1. Service disconnect switches
 - 2. Feeder and equipment disconnect switches
 - 3. Feeder branch-circuit protection
 - 4. Motor disconnect switches
 - 5. Bolt-on circuit breakers
 - 6. Switched Neutral circuit breakers

- B. Related CSI Sections: The following Sections contain requirements that relate to this section:
 - 1. Division 26 Section 260533, "Raceways and Boxes for Electrical Systems".
 - 2. Division 26 Section 262726, "Wiring Devices" for attachment plugs and receptacles, and snap switches used for disconnect switches.
 - 3. Division 26 Section 262813, "Fuses".

1.2 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- B. Product Data for switches, circuit breakers, and accessories specified in this Section. Include the following:
 - 1. Descriptive data and time-current curves.
 - 2. Let-through current curves for circuit breakers with current-limiting characteristics.
 - 3. Coordination charts and tables and related data.
 - 4. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.
 - 5. Include name, address, and telephone number of in-state supplier of spare parts. No out-of-state suppliers shall be permitted.

- C. Quality Assurance Submittals:
 - 1. Qualification data for firms and persons specified in Part 1.3 "Quality Assurance" to demonstrate their capabilities and experience. Include lists of completed

projects with project names and addresses, names and addresses of architects and owners, and other information specified.

- D. Maintenance Data: For tripping devices to include in the operation and maintenance manuals specified in Form 817 Article 1.20 – 1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – OPERATION AND MAINTENANCE MANUALS.
- E. Test and Inspection reports performed by an independent agency.

1.3 QUALITY ASSURANCE:

- A. Testing Agency Qualifications: The independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of NETA.
 - 1. Testing Agency's Field Supervisor: Person currently certified by NETA or the NICET, to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain disconnect switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from one source and by a single manufacturer.
- C. Comply with NFPA 70 for components and installation.
- D. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the NEC, Article 100.

1.4 COORDINATION:

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate installation of new circuit breakers in existing panels. Match existing panel KIC rating and manufacture.

1.5 SPARE PARTS:

- A. Furnish to the Engineer spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels described contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering disconnect switches and circuit breakers that may be incorporated into the Work include, but are not limited to, the following:

1. Fusible Switches:
 - a. Eaton Corp.; Cutler-Hammer Products
 - b. General Electric Co.; Electrical Distribution and Control Division
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
2. Molded-Case Circuit Breakers:
 - a. Eaton Corp.; Cutler-Hammer Products
 - b. General Electric Co.; Electrical Distribution and Control Division
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
3. Combination Circuit Breaker and Ground Fault Trip:
 - a. General Electric Co.; Electrical Distribution and Control Division
 - b. Siemens Energy & Automation, Inc.
 - c. Square D Co.
4. Molded-Case, Current-Limiting Circuit Breakers:
 - a. General Electric Co.; Electrical Distribution and Control Division
 - b. Siemens Energy & Automation, Inc.
 - c. Square D Co.
5. Integrally Fused, Molded-Case Circuit Breakers
 - a. General Electric Co.; Electrical Distribution and Control Division
 - b. Siemens Energy & Automation, Inc.
 - c. Westinghouse Electric Corp.; Distribution & Control Business Unit.
6. Bolt-on circuit breakers

- a. General Electric Co.
- b. Square D Co.

2.2 DISCONNECT SWITCHES:

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.
- C. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of the installed location.
 - 1. Outdoor Locations: Type 3R.

2.3 ENCLOSED CIRCUIT BREAKERS:

- A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.
- B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current.
- C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.
- D. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.
- E. Circuit Breakers, 400 A and Larger: Field-adjustable, short-time and continuous-current settings.
- F. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.
- G. Current Limiters: Where indicated, integral fuse listed for circuit breaker.
- H. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.
- I. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
- J. Shunt Trip: Where indicated.
- K. Accessories: As indicated.
- L. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

1. Outdoor Locations: Type 3R.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.
- B. Install disconnect switches and circuit breakers level and plumb.
- C. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.
 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- D. Identify each disconnect switch and circuit breaker according to requirements specified in CSI Division 26 Section 260553, "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL:

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- D. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers or per manufacturer's requirements. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panel so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker after the semi-final inspection.
 - c. Instruments and Equipment:
 4. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device
- E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.3 CLEANING:

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 262816

SECTION 265119 – LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY:

- A. This Section includes LED interior lighting fixtures and accessories for the complete indoor lighting as shown on plans.
- B. Related CSI Sections include the following:
 - 1. Division 26 Section 260519, “Low Voltage Electrical Power Conductors and Cables”.
 - 2. Division 26 Section 260529, “Hangers and Supports for Electrical Systems”.
 - 3. Division 26 Section 260533, "Raceways and Boxes for Electrical Systems".
 - 4. Division 26 Section 260923, “Lighting Control Devices”.
 - 5. Division 26 Section 262726, “Wiring Devices.”
 - 6. Division 26 Section 265219, “Emergency and Exit Lighting”.
- C. Description:
 - 1. The lighting system shall operate in universal voltage (both 120V and 277V), as called for on the Contract plans. LED luminaires shall be installed for general interior lighting.
 - 2. Panelboards, fixtures, outlets, receptacles, switches and all other applicable lighting system components and details shall be as shown on the plans or as specified.
 - 3. The plans show the location, number, size and type of lighting units and fixture schedule. All fixtures shall be UL listed.
 - 4. Lighting plans are diagrammatic, with fixture outlets located approximately to scale but not dimensioned. Raceways are not generally shown. The Contractor shall check lighting drawings against field conditions and the drawings of other disciplines for interferences and shall select and lay out locations for outlets and obtain approval for final locations from the Engineer.

1.2 DEFINITIONS:

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."

- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of luminaire.
- G. Luminaire: Complete lighting unit, including LED module(s), driver, reflector, and housing.

1.3 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Include photometric curves, illustrations, specifications, schedules and material lists with quantities showing complete details of all proposed equipment.
 - 1. Spare Parts: Include name, address, and telephone number of in-state supplier of spare parts. No out-of-state suppliers shall be permitted.
- C. Contract plans indicate the basis of design light fixtures. If the Contractor chooses to provide another manufacturer, a complete photometric lighting analysis showing all the illuminance levels, uniformity, lamp loss factor, luminaire depreciation, power densities, etc. shall be provided for review. The Department reserves the right to reject alternate luminaires based solely on photometric performance, lumen maintenance, and construction.
- D. Maintenance Data: For interior lighting to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08-14 subsection 2 and described in NOTICE TO CONTRACTOR – OPERATION AND MAINTENANCE MANUALS.

1.4 QUALITY ASSURANCE:

- A. Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 410 as applicable to installation, and construction of interior building lighting fixtures.
- B. Comply with UL standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide interior lighting fixtures and components which are UL-listed.

1.5 SEQUENCING AND SCHEDULING:

- A. Coordinate with other work including conductors and cable, raceways and boxes, to properly interface installation of interior lighting fixtures with other work.

1.6 COORDINATION:

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

1.7 SPARE PARTS:

- A. Furnish to the Engineer spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Fifteen percent drivers and LED modules, but not less than 2 of each type fixture.

1.8 WARRANTIES:

- A. Refer to Form 817 Article 1.20 – 1.06.08 and NOTICE TO CONTRACTOR – WARRANTIES for additional information.
- B. All lighting fixtures and components shall carry a manufacture’s warranty covering defects in material and workmanship for a minimum of five (5) years from the issuance of Certificate of Compliance.
- C. Replace defective and burned out modules and drivers for a period of one year following the date of Certificate of Compliance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, lighting manufacturers offering products that may be incorporated in the work are the following or an approved equal:

- 1. Holophane
- 2. Kenall
- 3. Pinnacle
- 4. Lithonia
- 5. EATON

2.2 MATERIALS:

- A. General: Lighting fixtures (luminaires) shall be complete with mounting brackets and hardware, led modules, drivers, installation accessories, fixture wire, and all accessories as required, as specified in the Fixture Schedule, as shown on the Contract plans and as required by NEC.
- B. Lighting Fixtures: Refer to lighting fixture schedule on contract drawing FEG-001.
- C. Refractors and Reflectors: All glassware and plastic shall be uniform, free from defects and photometrically tested for distribution by an independent testing laboratory. Plastic diffusers shall be of new virgin-acrylic plastic material. Designer reserves the right to review photometric test.
- D. Conduits: Conduit, including hangers and fittings, shall be installed where shown on the Contract Drawings and shall be in accordance with CSI Division 26 Section 260533, "Raceways & Boxes for Electrical Systems".
- E. Color of LED fixtures shall be 4000°K unless otherwise noted on fixture schedule.
- F. Fixture Wire: Fixture wire for lighting fixtures shall be as specified in CSI Division 26 Section 260519, "Low-Voltage Electrical Power Conductors & Cables."
- G. All fixtures shall be installed for seismic requirements.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine areas and conditions under which lighting fixtures are to be installed, and substrate for supporting lighting fixtures. Notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer and with approval of Engineer.

3.2 INSTALLATION:

- A. Install all luminaires, their components and associated supports, fittings, conduit, boxes, wiring and grounding conductors as called for in this section, as shown on the plans, as required and in accordance with the manufacturer's instructions and recommendations.
- B. Prior to the issuance of the Certificate of Compliance, thoroughly clean the luminaires, LED bars and accessories and shall replace any defective or inoperative LED fixtures.

- C. All fixtures shall be aligned and directed as shown or so as to illuminate the desired area properly. Fixtures shall be directly and rigidly mounted on their supporting structures using bolted connections. The conduit system shall not be used to support fixtures unless called for.
- D. Where aluminum contacts concrete or dissimilar metal, separate contact surfaces with gasket, nonabsorptive tape or bituminous coating to prevent corrosion. Use stainless steel fasteners.
- E. Fixtures shall be mounted plumb, level and in straight lines. Group-mounted LED fixtures shall appear as one unit. Rows of fixtures shall be installed accurately as to line and level. Fastenings and supports shall be firmly set so that the fixtures will not be distorted by handling incident to normal maintenance. All parts including LED modules shall be secured to prevent falling or dislocation. The use of tong type hangers for suspending LED fixtures is prohibited.
- F. Lighting fixtures shall be positioned to clear all obstructions.
- G. The minimum number of supports for surface mounted or suspended LED fixtures shall be one for each 4 ft of length plus one additional support: 4 ft-two (2) supports; 8 ft-three (3) supports; 12 ft-four (4) supports. Additional supports shall be provided if required. Attachment to structural steel shall be bolted type, anchors and inserts shall be installed as an integral part of structural system. Explosive or cartridge driven type inserts, anchors or supports are not approved.
- H. All auxiliary steel, supports and brackets of all kinds for safety erecting the fixtures shall be furnished and installed in place by the Installer.
- I. Where coordination with other equipment is necessary some departure from the locations shown may be permitted on approval of Engineer.
- J. All lighting units when installed shall be set true and shall be free of leaks, warps, dents or other imperfections.
- K. All lighting fixtures shall be directly grounded to the equipment grounding system by means of a conductor of size not less than that required by NEC. If insulated, the ground conductor insulation shall be colored green.
- L. Taps and splices shall be made with insulated wire nut connectors of the setscrew or spring type or with indent compression type connectors. Solid wire shall be terminated at screw type connections by looping around the terminal screw. At panelboards, solid wire may be terminated using screw type pressure terminals; stranded wire may be terminated using saddle type pressure terminals.
- M. All fixtures shall be installed for seismic requirements.

3.3 GROUNDING:

- A. Provide equipment grounding connections for interior lighting fixtures as indicated under CSI Division 26 Section 260526, "Grounding and Bonding for Electrical Systems".

3.4 FIELD QUALITY CONTROL:

- A. The Installer is not responsible for the foot candles of illumination provided by the completed systems. However, if after the lighting is installed and in operation, any areas are noted which are obviously under or overlit, the Installer shall promptly advise the Engineer.
- B. Fixtures shall be protected and maintained in good condition during construction. At the completion of the work, all fixtures shall be cleaned, inspected, and repaired, or replaced if damaged.
- C. Perform an insulation resistance test on the lighting wiring before energizing and verify correct operation.
- D. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- E. Luminaire will be considered defective if it does not pass operation tests and inspections.
- F. Prepare test and inspection reports.

3.5 ADJUSTING AND CLEANING:

- A. Clean interior lighting fixtures of dirt and construction debris upon completion of installation. Clean finger-prints and smudges from lenses.
- B. Protect installed fixtures from damage during remainder of construction period.

END OF SECTION 265119

SECTION 265219 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY:

A. Section Includes:

1. Emergency lighting units.
2. Exit signs.
3. Luminaire supports.

B. Related CSI Sections include the following:

1. Division 26 Section 260519, "Low Voltage Electrical Power Conductors and Cables".
2. Division 26 Section 260529, "Hangers and Supports for Electrical Systems".
3. Division 26 Section 260533, "Raceways and Boxes for Electrical Systems".
4. Division 26 Section 260923, "Lighting Control Devices".
5. Division 26 Section 262726, "Wiring Devices".
6. Division 26 Section 265119, "LED Interior Lighting".

1.2 DEFINITIONS:

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire."

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 SUBMITTALS:

A. Submit the following in accordance with Form 817 Article 1.20 – 1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- B. Product Data: Include photometric curves, illustrations, specifications, schedules and material lists with quantities showing complete details of all proposed equipment.
 - 1. Spare Parts: Include name, address, and telephone number of in-state supplier of spare parts. No out-of-state suppliers shall be permitted.
- C. Contract plans indicate the basis of design light fixtures. If the Contractor chooses to provide another manufacturer, a complete photometric lighting analysis showing all the illuminance levels, uniformity, lamp loss factor, luminaire depreciation, power densities, etc. shall be provided for review. The Department reserves the right to reject alternate luminaires based solely on photometric performance, lumen maintenance, and construction.
- D. Maintenance Data: For interior lighting to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08-14 subsection 2 and described in NOTICE TO CONTRACTOR – OPERATION AND MAINTENANCE MANUALS.

1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

1.5 DELIVERY, STORAGE, AND HANDLING:

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.6 WARRANTY:

- A. Refer to Form 817 Article 1.20 – 1.06.08 and NOTICE TO CONTRACTOR – WARRANTIES for additional information.
- B. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.

- C. 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 Power Unit Batteries: five (5) years from date of Substantial Completion.
 - 2. Warranty Period for Self-Powered Exit Sign Batteries: seven (7) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, emergency lighting and exit sign manufacturers offering products that may be incorporated in the work are the following or an approved equal:
 - 1. Exit Sign Warehouse
 - 2. Holophane
 - 3. Kenall
 - 4. Pinnacle
 - 5. Lithonia

2.2 PERFORMANCE REQUIREMENTS:

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. Luminaires and lamps shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.3 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING:

- 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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.

- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
 - 1. Emergency Connection: Operate fixture continuously upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 - 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - 2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - 3. Humidity: More than 95 percent (condensing).
 - 4. Altitude: Exceeding 3300 feet.
 - 4. Nightlight Connection: Operate lamp continuously at 50 percent of rated light output.
 - 5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - 1. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - 2. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 6. Battery: Sealed, maintenance-free, lead-acid type.
 - 7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - 8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
 - 9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- F. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Emergency Connection: Operate one LED fixture continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Nightlight Connection: Operate lamp in a remote luminaire continuously.
4. Battery: Sealed, maintenance-free, lead-acid type.
5. Charger: Fully automatic, solid-state, constant-current type.
6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.
7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
10. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.4 EMERGENCY LIGHTING:

- A. Refer to light fixture schedule on contract drawing FEG-001 for emergency lighting designated fixtures with integral battery pack.

2.5 EXIT SIGNS:

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Exit Signs: All exit signs shall be UL listed and LED illuminated and provided at all exits. All exit signs shall have red letters, 6" high with 3/4" width, and a diffuse background. Letters shall spell "EXIT" with a Wheelchair Accessible Symbol (ADA) next to letters.
- C. Exit sign
 1. Housing: die cast aluminum
 2. Lamp type: LED
 3. Operation: Nickel Cadmium Emergency

4. Frame: White painted die cast aluminum
5. Face/letter color: Stencil face, red letter (stencil matches housing color).
6. Number of faces: Single or double
7. Mounting: Wall mount or ceiling mount
8. Options: Self diagnostics with visual indicators.
9. Wheelchair Accessible Symbol (ADA)

2.6 MATERIALS:

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access:

1. Smooth operating, free of light leakage under operating conditions.
2. Designed to permit relamping without use of tools.
3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. Glass: Annealed crystal glass unless otherwise indicated.
2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated

D. Housings:

1. Extruded aluminum and heat sink.
2. Finish as noted above
3. Conduit: As specified in CSI Division 26 Section 260533, "Raceways and Boxes for Electrical Systems" and as indicated on plans.

2.7 METAL FINISHES:

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 LUMINAIRE SUPPORT COMPONENTS:

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gauge.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION:

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- E. Wall-Mounted Luminaire Support:

1. Attached to masonry or structural members in walls using fasteners approved for application by lighting manufacturer.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing for bay fixtures for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

- H. LED illuminated exit signs shall be provided at all exits. Internally illuminated directional exit signs shall be provided in corridors where direct sight of the exit is not possible, and at intersections of corridors. On long escape routes, directional exit signs shall be located no further than 100 ft apart. Each exit sign shall be oriented for maximum visibility from the egress route which progresses toward that sign, and shall be readily visible from the direction of exit access. Sign installation shall be in accordance with the latest approved edition of NFPA/NEC.

3.3 IDENTIFICATION:

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL:

- A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.5 STARTUP SERVICE:

- A. Perform startup service:
 1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING:

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 1. Inspect all luminaires. Replace emergency power units, batteries, or luminaires that are defective.
 1. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265219

SECTION 270526 – GROUNDING AND BONDING

PART 1 – DESIGN REQUIREMENTS

- 1.1 The purpose of a grounding system is to create a low resistance path that will carry electrical surges and transient voltages such as lightning, and electrostatic discharges to earth ground. A properly designed system is one that is visually verifiable, sized correctly for the expected currents, and directs potentially damaging currents away from equipment. Metallic component parts of the communication infrastructure such as equipment, cable trays, cabinets, racks, or blocks must be properly grounded and bonded.

PART 2 - BUILDING SINGLE GROUND POINT

- 2.1 A building's single grounding point will be the building's electrical service ground. This results in good contact with earth ground, and results in a low resistance to ground necessary for dissipating fault currents, lightning strikes, static discharges, electromagnetic frequency (EMF), and Radio Frequency Interference (RFI), safely into the earth.
- 2.2 An existing Bus Bar is installed in the Main Telecom Room that supports the technology equipment within the Main Telecom room.
- 2.3 All connections will be an IEEE-837 approved irreversible type compression fitting.
- 2.4 All non-conductive coatings such as paint, lacquer, and other electrically non-conductive coating must be removed from surface areas where connections are to be made to ensure a good electrical connection. The use of a star washer does not satisfy the requirement to remove non-conductive coatings from attachment surfaces.
- 2.5 The resistance from the ground system to the physical earth ground shall be 25 ohms or less, and the resistance from the protector to the ground system (equipment ground) should be less than 1 ohm.

PART 3 - TELECOMMUNICATION BONDING BACKBONE

- 3.1 A new bus bar shall be installed in the Main Telecom room next to the existing Main Bus Bar to support Communication rooms G-134, G-318 and G-303 VDTR.
- 3.2 A # 6/0 AWG, insulated(green jacket) cable shall be installed from the new Bus Bar in the Main Telecom Room to each of the Communication rooms. G-134 and G-318 and the VDTR room G-303
- 3.3 The Telecommunication Bonding Backbone (TBB) intended function is to equalize or reduce potential differences in the telecommunication system's grounding and bonding infrastructure.
- 3.4 The TBB will be a continuous 6/0 AWG cable from the TMGB to the TGB's. Typically, the TBB will connect all TGB's normally found in the building's Entrance Facility (EF), and in all Communication rooms.
- 3.5 The TBB will be installed as a continuous cable without splices.

- 3.6 All connections to the TBB must be accessible and be made with irreversible compression fittings.
- 3.7 Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it becomes necessary to place grounding or bonding cable in a metallic conduit, the conduit shall be bonded at each end with a ground hub and minimum #6 AWG bonding conductor.
- 3.8 Ground buss conductors must maintain a minimum bend radius as required by code. The angle of any bend must not be less than 90 degrees.

PART 4 - TELECOMMUNICATION MAIN GROUNDING BUS BAR

- 4.1 The Telecom Main Grounding Bus bar (TMGB) serves as an extension of the building ground point for the purpose of grounding the telecommunications infrastructure. The Telecom Main Grounding Bus bar is located in the Main Telecom room.
- 4.2 The TMGB provides a central attachment point for all of the building's Telecommunication Bonding backbones (TBB). The TMGB will be bonded to building grounding system and grounded / earthed to the electrical service ground according the current version of the NEC.
- 4.3 The TMGB will be found in the building's Main Communications room. The Main Communications room may or may not be the building's Entrance Facility (EF). The bonding conductor will be directly attached between the building's single ground point, normally the electrical service ground at the building's entrance, and the building's Main Telecommunication room.
- 4.4 The bonding conductor between the building's main grounding point and the TMGB in the Main Telecom room will be a minimum of #3/0 AWG, insulated appropriately colored conductor, utilizing an exothermic connection. This conductor already exists in the Main Telecom Room.
- 4.5 Provide a TMGB that is UL listed, 2" wide x ¼" thick. The length of the TMGB shall be determined by the number of connections required but shall not be less than 12". The TMGB shall accept 2-hole lugs and be supported from the wall by stand-off brackets made of acceptable materials. The TMGB shall be located above the highest piece of wall mounted equipment to allow for adequate access for grounding conductors and connections.
- 4.6 The TMGB shall be insulated from its support, and be capable of safely carrying powerful currents. Before a mechanical connection is made, the attachment area should be thoroughly cleaned prior to fastening of conductors. Apply anti-oxidant to the tongue of the connector before the bonding connection is made, to reduce corrosion and contact resistance.
- 4.7 All connections to the TMGB other than the main ground wire will be made through the use of UL listed 2-hole, irreversible compression lugs.

PART 5 - TELECOMMUNICATION GROUND BAR

- 5.1 The Telecommunication Ground Bus bar (TGB) serves as the single grounding and bonding point for all telecommunication systems and equipment located in that particular location's

Communications room. The Communication rooms that will have a TGB will be G-134, G-318 and G-303 VDTR.

- 5.2 The TGB will be UL listed 2" wide x ¼" thick. The length of the TGB shall be determined by the number of connections required but shall not be less than 12". The TGB shall accept 2-hole lugs and be supported from the wall by stand-off brackets made of acceptable materials. The TGB shall be located above the highest piece of wall mounted equipment to allow for adequate access for grounding conductors and connections.
- 5.3 All connections to the TGB other than the main ground will be made through the use of UL listed 2-hole, irreversible compression lugs.
- 5.4 Each TBB that bonds a TGB to the building's TMGB must be bonded with UL listed irreversible compression fittings.

PART 6 - EQUIPMENT GROUNDING

- 6.1 All equipment inside the communications rooms shall be bonded to the TGB with a #6 AWG appropriately colored bonding conductor. This includes, but is not limited to:
 - A. Equipment Racks
 - B. Equipment Cabinets
 - C. Ladder Racks
- 6.2 Bond ladder rack at each mechanical runway connection or joint using a #6 AWG jumper across each connection/joint, or an acceptable proven method to maintain continuity between equipment, i.e. joining of two pieces of ladder rack.
- 6.3 All non-conductive coatings such as paint, lacquer, and other electrically non-conductive coating must be removed from surface areas prior to making a physical connection to ensure a good electrical connection can be made. The use of a star washer does not satisfy the requirement to remove non-conductive coatings from attachment surfaces.
- 6.4 Prior to making a bonding connection, thoroughly clean the attachment area. Apply anti-oxidant to the tongue of the connector before attachment to the contact area in order to prevent corrosion and reduce contact resistance.

END OF SECTION 270526

SECTION 271313 – COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 – GENERAL

1.1 SCOPE OF WORK

- A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, and labeling of termination blocks and patch panels as described on the drawings and/or required by these specifications.

1.2 RELATED SECTIONS

- A. Division 27, Section 271513 Communications Copper Horizontal Cabling.

1.3 REFERENCE STANDARDS

- A. Comply with the following unless indicated otherwise:
 - 1. NFPA 70

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For features, ratings, and performance of each component specified.
- C. Submit manufacturer's instructions for storage, handling, protection, examination, preparation, operation, and installation of products. Include application conditions or limitations of use stipulated by any product testing agency. Submit for the following:
 - 1. 110 Blocks.
 - 2. 66 Blocks
 - 3. Patch Panels.
 - 4. Wire management.
- D. Shop Drawings:
 - 1. Component List: List manufacturer, part number, and quantity of each component.
 - 2. Include dimensioned plan and elevation views of equipment rooms, labeling each individual component. Show equipment rack assemblies, method of field assembly, workspace requirements, and access for cable connections.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 Certified, for components that are required to have submittals provided as part of this Section.
- B. Installer Qualifications:
 - 1. A firm currently engaged and which has been continuously engaged for the past 5 years in the installation of low voltage applications of type required for this Project, and which is licensed in and has obtained or will obtain the necessary permits to perform telecommunications installations in jurisdiction where Project is located.
 - 2. Have a BICSI certified RCDD locally on staff
 - 3. Provide references of the type of installation provided in this specification.
 - 4. Have personnel knowledgeable in local, state, and national codes and the latest TIA Telecommunications Standards and Manufacturer's recommendations.
 - 5. Have personnel fluent in the use of AutoCAD version 2002 or later and possess and operate CAD software capable of producing .DWG or .DXF format.
- C. Source Limitations: Obtain units of the same type of equipment through one source from a single manufacturer.
- D. Product Options: Drawings indicate size, profiles, and dimensional requirements of equipment, accessories, and components and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
 - 1. Do not modify intended aesthetic effects or performance, as judged solely by Resident Engineer, except with Resident Engineer's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- E. Materials and labor shall comply with applicable requirements of following standards, using latest version of associated appendices and Technical Service Bulletins at the time of award of the Contract;
 - 1. EIA/TIA-568.
 - 2. EIA/TIA-569.
 - 3. EIA/TIA-606.
 - 4. EIA/TIA-607.
 - 5. Underwriter's Laboratory.
 - 6. FCC (including CFR 47 and Part 68 – Subpart F).
 - 7. National Electric Code.
 - 8. NFPA 130.
 - 9. Local and State Codes.
 - 10. ISO/I/EC 11801.
 - 11. IEC 1000-5-2.
 - 12. IEC 60603-7.
- F. Backbone copper cabling is the portion of the telecommunications cabling system that provides the interconnections between the Main Telecommunications Room, G201 and Communications rooms G-318 and G303. Backbone cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or

jumpers used for backbone-to-backbone cross-connection.

- G. The backbone copper cabling shall be installed in a hierarchical star topology with no more than two levels of cross-connects.
- H. The backbone copper cabling will be used to support the connectivity for the phone system and other DOT dry copper circuit needs.
- I. Backbone copper cabling shall consist of a minimum 200-pair, Category 3 rated unshielded and shielded twisted pair cables are required.
- J. Backbone copper cabling shall comply with ICEA S-90-661-2012, NEMA WC 63.1, and TIA-568-A for Category 3 cables and shall be certified to meet transmission characteristics of Category 3 cable at frequencies up to 16 MHz.
- K. Backbone copper cables shall be rated (CMR or CMP) per the installation environment as required by the local AHJ and local codes. Select an appropriate cable construction, including external jacket properties, when installing cables in aerial, outdoor, underground and corrosive environments.
- L. Copper backbone cabling shall be terminated on Ortronics 110 and/or 66 blocks within the Communication rooms. Copper cross-connections are to be permanently punched down.

G201 to G318

- 1 200 pair cat 3 unshielded Plenum rated from G-201 to G-318. Terminations onto 110 blocks in G318 and termination to existing 66 blocks in G201. Terminate 24 pairs onto a 24 port patch panel and wall mount next to the 110 blocks in G-318. The remaining pairs to be terminated onto the 110 blocks. The 24 pairs shall be the last pairs in the 200 pair cable.
- 1 200 pair cat 3 unshielded Plenum rated from G201 to G-318. Terminations onto 66 blocks in G318 and termination to new 66 blocks in G201 by radio equipment

G201 to G303

- 1 200 pair shielded cable Riser rated from G303 (VDTR) shall be terminated on a Ortronics 96 port patch panel(RJ45) in cabinet C03. In the G201 side the 200 pair shall be terminated onto existing 66 blocks. Cable shall be installed through 3" conduit

- M. The backbone copper cable label shall consist of a plastic type etch able phenolic tag attached with a plastic tie wrap. Plastic label shall be red in color, and have a white etched cable ID on surface. This tag shall be approved for interior and exterior use. White color tie wraps shall be used indoors. Riser rated labels and tie wraps shall be used where required.

- N. The backbone copper cable sheath label shall contain copper cable name which is made up of the media type, cable size, fiber type, source room number, destination room number and cable number.

PART 1 - PRODUCTS

2.1 Backbone Copper Cable Specifications

- A. The backbone copper cable shall support the following applications:
1. Analog and Digital Voice
 2. ISDN
 3. DSL, etc.
 4. T-1 lines
- B. Cable assembly shall consist of 200 pairs and 2 fillers cabled together with overall nylon binders.
- C. Jacket shall consist of no lead flame retardant thermoplastic with a ripcord for easy jacket removal.
- D. Individual pair colors shall adhere to industry standards.
- E. Pulling tension shall be 600 lbs./1000 feet, minimum.
- F. Operating temperature shall be 140 degrees F (60 degrees C), maximum.
- G. The backbone copper cable shall meet the following minimum requirements:

Pair Count	200
Conductor	Solid annealed copper
Insulation	FEP
AWG	24
Separator	Cylindrical
Jacket	White, fluoropolymer
Characteristic Impedance (ohm)	100 ± 15
Nominal Velocity of Propagation (%)	64
Performance Compliance	UL 444, UL 1666 CSA C22.2 No. 214-08 UL 1666 NFPA 262 ANSI/TIA-568-C.2 ANSI/ICEA S-90-661-2012 Article 800, NEC (NFPA 70) RoHS- compliant RoHS 2-compliant

NRTL Programs	UL Verified CAT 3 UL, c(UL) Listed CMR UL, c(UL) Listed CMP
---------------	---

2.2 Manufacturers

1) Shielded 200 pair Cat 3 Copper Cable

- 200 Pair Cat 3 shielded – Superior Essex Cable 24 AWG 200 Pair ARMM Series CMR Copper cable 02-108-03
- Or approved equal

2) Unshielded 200 pair Cat 3 Copper Cable

- 200 Pair Cat 3 unshielded – Superior Essex Cable 24 AWG 200 Pair ARMM Series CMP Copper cable 18-A99-36
- Or approved equal

3) Ortronics Patch Panels– 24 and 96 Port Patch Panels

- OR-PHD5E8U96 – 96 port patch panel to be installed in G-303
- OR-SP5EU24 - 24 port patch panel to be installed onto wall in G-318 next to 110 blocks.
Contractor to furnish and install open wall mount for 24 port patch Panel onto plywood backboard.

4) Ortronics 110 Blocks

- 100 pair 110 Field Termination Block kit with 110C4s
OR-30203506

5) Siemons - 66 Blocks

- S66M1-100

Note: Contractor to provide a complete installation for all cabling which shall include cable Management and strapping, etc.

PART 3 - EXECUTION

3.1 Installation

- A. Installation shall comply with TIA-568-C.1.
- B. Installation shall comply with BICSI's "Information Transport Systems Installation

Methods Manual (ITSIMM)," Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.

- C. Install 110 and 66 IDC termination hardware unless otherwise indicated.
- D. Shielded cabling shall be grounded to bus bar in communication room.
- E. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
- F. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- G. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
- H. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section Use lacing bars and distribution spools.
- I. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
- J. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
- K. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
- L. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- M. Pulling tensions shall be monitored continuously during installation and shall not exceed manufacturer's recommended pull tension.
- N. A cable lubricant specifically manufactured for cable pulling lubrication purposes and compatible with the cable sheathing material may be used on cables pulled in conduits or ducts to meet pull tension requirements. Petroleum grease shall not be used as a cable lubricant.

- O. All cabling shall be run in such a manner that bundles appear straight and pleasing to the eye within the raceways and cable trays. No cables should twist around another and one should be able to follow with the eye a cable from ceiling penetration to patch panel.
- P. Install a pull string in all empty conduits and conduits that are not filled to the maximum 40% fill capacity.
- Q. Ty-rap style plastic cable ties shall not be used to bundle cables. Only wide Velcro strips or an equivalent should be used to bundle or otherwise secure cables.
 - 1. All cable and port labels shall be machine printed. Hand printed labels are not acceptable. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.
 - 2. Do not untwist twisted pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
 - 3. Separation from EMI Sources:
 - a. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
 - b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - c. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - d. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - e. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
- R. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 1. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - 2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - 3. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

- S. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - 1. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 2. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
 - 3. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
- T. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
- U. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm)

3.2 Testing

- A. All cables shall be tested in accordance with ANSI/TIA standards, the Manufacturer's Certification Program and best industry practice. The field test equipment shall meet the requirements of ANSI/TIA -568-C including applicable TSB's and amendments. The appropriate Level III tester shall be used to verify Category 5E and 6A cabling systems. The test protocols, testing approach and equipment will be contained in the test results documents.
- B. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance.
- C. Horizontal cabling shall be tested using a Level III test unit for Category performance compliance.
- D. Continuity: Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
- E. Length: Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block,

patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568-C Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.

F. The basic tests required are:

1. Wire Map
2. Length
3. Attenuation
4. NEXT (Near end crosstalk)
5. ACR (Attenuation to crosstalk ratio)
6. Return Loss
7. ELFEXT Loss
8. Propagation Delay
9. Delay skew
10. PSNEXT (Power sum near-end crosstalk loss)
11. PSACR (Power sum attenuation to crosstalk ratio)
12. PSELFEXT (Power sum equal level far-end crosstalk loss)

G. Category 3 Channel Testing

1. Category 3 Performance
 - a. Each cable shall meet the channel requirements outlined below for a 100-meter, 4-connector channel.

FREQUENCY (MHZ)	MAXIMUM INSERTION LOSS (DB)	MINIMUM NEXT (DB)	MINIMUM PSNEXT (DB)	MINIMUM ACR (DB)	MINIMUM PSACR (DB)	MINIMUM RETURN LOSS (DB)
1.0	2.2	50.0	46.0	47.8	46.1	12
4.0	4.0	41.0	37.0	36.0	43.8	12.0
8.0	6.3	36.0	32.0	28.3	32.0	12.0
10.0	9.0	35.0	31.0	26.2	24.3	12
16.0	11.3	32.0	28.0	20.1	22.2	10

END OF SECTION 271313

SECTION 271513 – COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, and labeling of copper backbone infrastructure as described on the Drawings and/or required by these specifications.

1.2 REFERENCE STANDARDS

- A. Comply with the following unless indicated otherwise:
 - 1. NFPA 70.

1.3 COORDINATION

- A. Contractor shall coordinate the work specified in this Section with the work in other parts of the Contract document.
- B. Plans in general are diagrammatic. It is the full responsibility of the Contractor to be familiar with the location of equipment involved under the work of other trades to eliminate conflicts between the multi pair copper cable installation and the work of other trades.
- C. All questions and issues with regard to coordination shall be directed to the Engineer.

1.4 SUBMITTALS

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. The Contractor shall submit a Copper cable pulling plan for all multi pair copper cables that includes, but is not limited to the following:
 - 1. Each cable run and route.
 - 2. Date and duration of the pull.
 - 3. Pulling methodology and equipment setups.
 - 4. Pulling tension calculations for each pull in the run.
 - 5. Safety issues and precautions to be taken.

1.6 QUALITY ASSURANCE

- A. Verification: The engineer will maintain inspection personnel on the job site. It is incumbent upon the Contractor to verify that the installation and material used has been inspected before it is enclosed within building features, or otherwise hidden from view. The Contractor shall

bear costs associated with uncovering or exposing installations or features that have not been inspected.

- B. Equipment Qualifications: The Contractor is to use equipment and rigs designed for pulling, placement and termination of multi pair copper cable; including reel trucks, mechanical mules, sheaves, shoes, anchors etc., and equipment for drilling masonry, installing anchors, etc., to install support and cable management hardware.

PART 2 – PRODUCTS

2.1 CABLE SPECIFICATIONS

- A. UTP Category 6A cable shall exceed all requirements for ANSI/TIA-568-C.2 and ISO/IEC 11801 Class EA requirements and support the following high-speed communication network applications:
 - 1. 10BASE-T through 10GBASE-T Ethernet
 - 2. Power over Ethernet (PoE & PoE+) - IEEE 802.3at and 3af Type 1 and 2
 - 3. 4PPoE+ - IEEE 802.3bt Type 3 and 4 draft D1.2
 - 4. ATM and Token Ring
 - 5. Backward compatible to legacy protocols and applications
 - 6. HDBaseT Class A and B
- B. Category 6A cable shall be factory tested verifying that final production reels are tested to at least 650 MHz and conform to all ANSI/TIA Category 6A requirements. In addition, cabling shall be backwards compatible to legacy protocols and applications.
- C. Cables shall be marked as UL verified with a minimum of a Category 6A (or latest approved standard) rating.
- D. All cable shall utilize the appropriate sheath for the particular application. Any cable placed in space used as an air return or in any way connected with air handling plenums or building ventilation shall be low-smoke, fire retarding cable, and must comply with the National Electrical Code Articles 725, 760, and 800.
- E. Conductor shall be 23 AWG (minimum) solid, bare, annealed copper in a core of four balanced twisted pairs held in place by a full cross-web separator.
- F. Cables shall be marked as UL verified with a minimum of a Category 6A (or latest approved standard) rating.
- G. The following jacket colors shall be used to represent specific systems and/or applications:
 - a. Voice – Gray

- b. Data– Yellow
- c. Wi-Fi – Purple

2.2 CABLE MANUFACTURERS

1) Cat 6A – LANmark-XTP UTP Plenum – Yellow
Part number: 11090591

2) Cat 6A – Belden – 10GXS33 – Multi-conductor – Plenum rated
Part number: 10GXS33 004 1000 – Yellow

3) Or approved equal

Note: All cables for Wi-Fi shall be purple in color.

2.3 TERMINATIONS

1. Wall outlets and floor outlet configurations

A. Modular Connectors:

1. The connector module shall meet or exceed the Category 6A where applicable performance criteria per ANSI/TIA-568-C.2 and ISO/IEC 11801 Class EA requirements.
2. All modules shall utilize “RJ-45 style” 8-position, 8-conductor data jacks. All jacks shall be terminated to the 568B wiring scheme.
3. The connector shall snap into an industry standard keystone type opening.
4. The connector module shall be available in both the T568A and T568B wiring configurations within the same module.
5. The connector module shall have an insulation displacement connection featuring insulation splicing of 22 to 24 AWG plastic-insulated solid copper conductors forming a gas-tight connection.
6. Modules shall have replaceable/reusable icons denoting data and voice connections at a minimum.

B. Manufacturers

- 1) Siemon – Z-MAX 6A
 - Jacks – Z6A-X-09-X – Orange for Data
 - Jacks – Z6A-X-20-X - Ivory for Voice
 - Jacks – Z6A-X-08-X - Purple for Wi-Fi

No equals shall be permitted.

2. Faceplates and Outlet Housings

1. Faceplate and outlet housing connector openings shall be the industry standard keystone type.
2. Faceplate shall be available in 4 and 6 port configurations.
3. Faceplates shall be available in single- and double-gang format.
4. Faceplates for wall-mounted phones shall be one (1) port single gang faceplates that have wall-mount lugs allowing vertical phone mounting.
5. Flush mount faceplates and boxes shall be provided at all locations unless otherwise noted. Exceptions to the specifications which request surface mounting in lieu of flush must be submitted and obtain approval from engineer prior to installation.

A. Manufacturers

Wall mount configuration – 10G MAX Faceplates

1) Siemon

- 10G MX-FPS-04 (XX) – 4 port single gang 10G faceplate for Z-MAX 6A UTP outlet
- 10GMX-FPD06-02 – 6 port double gang 10G faceplate for Z-MAX 6A UTP outlet
- MX-FP-CVR-00 Clear covers for Max faceplates

Note: If a port is not being used on the faceplate a blank cover is required

Floor terminations – Surface Mount boxes

- 1) Surface mount boxes shall be coordinated with the floor box or poke thru device that will be selected and installed for the project.
- 2) Surface mount boxes shall provide a labeling location using built-in labeling windows for both the individual outlet port and the entire outlet housing location.

Siemon

- Z-MAX surface mount 4 port boxes
Part number: MX-SMZ4-20-X
- Z-MAX surface mount 6 port boxes
Part number: MX-SMZ6-20-X

Note: All necessary labeling shall be provided and any blank port to have a blank cover

2. Or approved equal

2.4 PATCH PANELS

A. Where Category 6A cabling is required:

1. Category 6A, T568B wired patch panel, with 48 ports.
2. Patch Panels: Patch panels shall be Cat6A compliant.

B. Approved Manufacturers:

1. Siemon
Part number: MX-PNL-48 – This is an unloaded patch panel
2. Jacks are to be provided to support all cabling into patch panels. Refer to Section 3.1 for jack types

2.5 WALL MOUNT RACKS FOR PATCH PANELS

A. Wall mounted bracket must be designed to work with manufacturer patch panel and network switches

B. Must be swing out style with reversible hinge

C. Approved Manufacturers:

1. CPI – Standard Swing Gate Wall Rack
Part number: 11807-X18 – 26U
2. Siemon
3. Or approved equal

2.6 WIRE MANAGEMENT FOR EQUIPMENT

A. Horizontal Wire Management for copper

1. Provide 2U high horizontal wire management with covers.

B. Vertical Wire Management for copper

1. Provide 4” W x 6” D vertical wire management with covers on the front and back and on either side of each equipment rack.

2. Bracket kit required for wire management between adjacent frames
- C. Horizontal Fiber Management Panel for fiber
1. Provide 2U high horizontal wire management with covers.
- D. Approved Manufacturers:
1. CPI
 2. Siemon
 3. Or approved equal

2.7 OUTLET LOCATIONS IN WIREMOLD

- A. Outlet Locations in Divided Raceways
1. In Area B Room 131 shall requires Wiremold above the desktop per note 11 on drawing FLV-102
 2. Contractor to provide shop drawings of Wiremold type

PART 3 – EXECUTION

General

1. All installation shall be done in conformance with ANSITIA-568B and manufacturer's installation guidelines. The Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the Contractor during the implementation.
2. The installation shall meet all applicable national and local codes pertaining to low voltage cable system installations.
3. All data cabling shall be terminated to the ANSI/TIA-T568B standard.
4. Contractor to follow drawings for data outlet types for Areas A and Areas B. Refer to FLV-001 for legend of outlet types.
5. Horizontal Cabling shall be installed inside conduits, cable trays or ladder racks where acceptable. The use of cable trays to support cables in accessible or exposed ceilings is acceptable in compliance with approved design. In no instance are D-rings acceptable. Enterprise cabling in Area A shall be neatly bundled and installed in cable troughs alongside ITS data wiring under the access floor
6. At any point where horizontal cables and tie cables installed within ceiling spaces must cross electrical circuits, cabling shall be routed at right angles to the electrical power circuits.

7. Install all horizontal cabling so that the cable jacket terminates within the Jack itself and no pairs are exposed. Pair untwist at the termination shall not exceed 3.18 mm (0.125 inch).
8. Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
9. Pulling tensions shall be monitored continuously during installation and shall not exceed manufacturer's recommended pull tension.
10. A cable lubricant specifically manufactured for cable pulling lubrication purposes and compatible with the cable sheathing material may be used on cables pulled in conduits or ducts to meet pull tension requirements. Petroleum grease shall not be used as a cable lubricant.
11. CAT 6A Data Terminations within the Communications room shall occur on the 48 port patch panel. Cabling numbering will be installed from left to right using the next available slot within the patch panel. The location within the patch panel will determine the ID number portion of the cable identification labeling.
12. Under no circumstances will the splitting of data cable pairs be allowed. The integrity of all four (4)-pair cable must be maintained end-to-end.
13. All cabling shall be run in such a manner that bundles appear straight and pleasing to the eye within the raceways and cable trays. No cables should twist around another and one should be able to follow with the eye a cable from ceiling penetration to patch panel. No service loops may be left in the cable tray.
14. Install a pull string in all empty conduits and conduits that are not filled to the maximum 50% fill capacity.
15. Ty-rap style plastic cable ties shall not be used to bundle cables. Only wide Velcro strips or an equivalent should be used to bundle or otherwise secure cables.
16. All cable and port labels shall be machine printed. Hand printed labels are not acceptable. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

Category Testing Requirements

- A. Upon installation of cable and before energizing, demonstrate product capability and compliance with requirements as contained in ANSI/TIA-568-C.2 and C.3 (including all TSBs) testing and certification standards.

- B. All Category 6A cabling shall be tested using a Level III-compliant tester as defined in ANSI/TIA-1152.
- C. Test equipment used shall have been certified calibrated by the manufacturer or an independent test and calibration firm, to the manufacturer's specifications. Meter calibration shall be performed within one year of the testing date.
- D. All cables shall be tested in accordance with ANSI/TIA standards, the Manufacturer's Certification Program and best industry practice. The field test equipment shall meet the requirements of ANSI/TIA-568-C including applicable TSB's and amendments. The appropriate Level III tester shall be used to verify and 6A cabling systems. The test protocols, testing approach and equipment will be contained in the test results documents.
- E. All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance.
- F. Horizontal cabling shall be tested using a Level III test unit for Category performance compliance.
- G. Continuity: Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers recommended procedures, and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
- H. Length: Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568-C Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
- I. The basic tests required are:
 - 1. Wire Map
 - 2. Length
 - 3. Attenuation
 - 4. NEXT (Near end crosstalk)
 - 5. ACR (Attenuation to crosstalk ratio)
 - 6. Return Loss

7. ELFEXT Loss
8. Propagation Delay
9. Delay skew
10. PSNEXT (Power sum near-end crosstalk loss)
11. PSACR (Power sum attenuation to crosstalk ratio)
12. PSELFEXT (Power sum equal level far-end crosstalk loss)

K. Category 6A Performance

1. Category 6A Performance: Each cable shall meet the channel requirements outlined below for a 100-meter, 4-connector channel.

FREQ (MHZ)	MAXIMUM INSERTION LOSS (DB)	MINIMUM NEXT (DB)	MINIMUM PSNEXT (DB)	MINIMUM ELFEXT (DB)	MINIMUM PSELFEXT (DB)	MINIMUM RETURN LOSS (DB)	MINIMUM ACR (DB)	MINIMUM PS ACR (DB)
1	2.1	74.3	72.3	67.8	64.8	20.0	72.2	70.2 59.5
4	3.8	65.3	63.3	55.8	52.8	23.0	61.5	59.5
8	5.3	60.8	58.8	49.7	46.7	24.5	55.4	53.4
1	5.9	59.3	57.3	47.8	44.8	25.0	53.4	51.4
16	7.5	54.8	54.2	43.7	40.7	25.0	48.8	46.8
20	8.4	53.3	52.8	41.8	38.8	25.0	46.4	44.4
25	9.4	51.9	51.3	39.8	36.8	24.3	44.0	42.0
31.25	10.5	41.9	49.9	37.9	34.9	23.6	41.4	39.4
62.5	15.0	47.4	45.4	31.9	28.9	21.5	32.4	30.4
100	19.1	44.3	42.3	27.8	24.8	20.1	25.2	23.2
155	24.1	41.4	39.4	24.0	21.0	18.8	17.4	15.4
200	27.6	39.8	37.8	21.8	18.8	18.0	12.2	10.2
250	31.1	38.3	36.3	19.8	16.8	17.3 1	7.3	5.3
300	34.3	37.1	35.1	18.3	15.3	16.8	2.9	0.9
400	40.1	35.3	33.3	15.8	12.8	15.9		
500	45.3	33.8	31.8	13.8	10.8	15.2		

2. In addition to testing the "In-link" performance parameters detailed above, Alien Crosstalk testing or "Between-link" testing shall be carried out in accordance with Section 4.7 of ANSI/TIA-1152. Alien crosstalk testing includes the PS ANEXT and PS AACR-F (Power sum alien attenuation-to-crosstalk ratio from the far end) performance parameters. The standards refer to the link-under-test for Alien Crosstalk as the disturbed link.

3. Alien Crosstalk testing shall be performed using a sampling plan. An acceptance quality level (AQL) of 0,4 %, normal inspection, general inspection level I as defined in ISO 2859-1 for populations of up to 500,000 links shall be used. The following table represents this sampling level.

Installation size (No. of total links)	Sample size (No. of links to test)
3 – 33	100%
34 – 3,200	33
3,201 – 35,000	126
35,001 – 150,000	201
150,001 – 500,000	315

L. Testing Documentation

1. Test reports shall be submitted in hardcopy and electronic format. Hand-written test reports are not acceptable.
2. Hardcopy reports are to be submitted in labeled 3 ring binders with an attached affidavit verifying passing execution of all tests. Hardcopy summary reports shall contain the following information on each row of the report: circuit ID, test specification used, length, date of test, and pass/fail result.
3. Electronic reports are to be submitted on USB format. If proprietary software is used, USB shall contain any necessary software required to view test results. If the results are delivered in a standard format like Excel, Access, CSV, PDF files, etc. then software to read these files is not required to be provided. Electronic reports must be accompanied by a Certificate signed by an authorized representative of the Contractor warranting the truth and accuracy of the electronic report.
4. Cable identification tags/numbers on cable test reports shall meet the cable identification/tag on the faceplate, patch panel, etc. label.

M. Certification and Warranty of Horizontal Cable Plants

O. Certification:

1. The engineer requires that the contractor certifies and provides verification from the relevant manufacturer for every horizontal cable permanent link installed in the project at project completion. Project schedules may dictate that

cables are certified as they are installed due to active system turn-up.

END OF SECTION 271513

SECTION 275119 - SOUND MASKING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. The work of this Section consists of the provision of all plant, materials, labor and equipment and the like necessary and/or required for the complete execution of all Sound Masking System and related work for this project, as required by the schedules, and keynotes and plans.

B. Functional Requirements of Systems:

1. Distribute sound masking to all areas as indicated on the plans.

C. Definitions:

1. Privacy Index: According to ASTM Standard E1130.
2. Octave and 1/3-Octave Bands: Centered on ANSI/ISO preferred frequencies.
3. Sound Level Meter and Filter Set: Calibrated ANSI Type 1 or Type 2.
4. Pink Noise: Constant energy in constant percentage (e.g. 1/1 or 1/3 octave) frequency bands, random or pseudo-random noise.
5. SPL: Sound pressure level in dB re 0.00002 Pa (0.0002 microbar).
6. ISO: International Standards Organization
7. NEC: National Electrical Code
8. UL: Underwriters Laboratories

1.2 SUBMITTALS

A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Working Drawings (Delegated-Design Submittal): For Sound Masking System signed and sealed by the qualified professional engineer.

1. Indicate compliance with performance requirements and design criteria, including analysis data.
2. The sound masking system shall utilize specially filtered audio signal that adds ambient noise as described by the NC-40 Contour.
3. The sound masking system shall be designed to function without the need for repairs for a minimum of 10 years based on the system operating 24 hours a day 7 days a week.
4. Indicate the Following on Reflected Ceiling Plans:

- a. Include all six (6) zones as described in this specification.
 - b. Locations of all ceiling loudspeakers.
 - c. Locations for all mounted controllers.
 - d. Method of attaching hangers to building structure or building system.
 - e. All control, amplification, and loudspeaker equipment shall be supplied.
 - f. Dimensions and locations of all speakers and components of the system.
 - g. Coordinated drawings with all other ceiling-mounted items including light fixtures, diffusers, grilles, sprinklers, and access panels.
- C. Product Data: For each component of the noise cancelling system.
- D. Sample Warranty: For special warranty.
- E. Maintenance Data: For sound masking systems to include in maintenance manuals to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.3 QUALITY ASSURANCE

- A. To be considered qualified for this work, the contracting firm must be experienced in the provision of sound systems similar in complexity to those required for this project, and meet the following:
- 1. The Contractor's primary business is the provision, fabrication, and installation of distributed sound and related systems.
 - 2. The Contractor is an authorized dealer for the major product components furnished.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package components individually in cardboard per manufacturer.

1.5 FIELD CONDITIONS

- A. Coordinate work with adjacent work of other trades to facilitate construction and prevent conflicts.

1.6 WARRANTY

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Warranty all equipment to be free of faulty workmanship and defects and from damage due to contamination by construction dust and debris for one year from the issuance of the Certificate of Compliance for control modules and 5 years for loudspeakers.
- C. Provide a one-year service contract to commence after acceptance of installation without additional cost. Service to include two semi-annual visits to the site for routine adjustment and maintenance of all equipment. Provide a preliminary schedule for the semi-annual visits.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Cambridge Sound Management or approved equal for all loudspeakers shall be direct field, radiating directly into the space.
- B. The sound masking system shall have one (1) controller to control six (6) individual controllable zones. The system shall provide:
 - 1. One wall-mounted controller, with six zones and one or more line level audio inputs.
 - 2. Uncorrelated noise sources per zone as indicated in the drawings. The signals to adjacent loudspeakers shall be uncorrelated.
 - 3. Direct field loudspeakers that automatically sequence the four noise channels and that are mounted either in office ceiling tiles or other enclosures.
 - 4. Cat 3/5/6 preterminated cable assemblies.
 - 5. The six (6) zones for the sound masking system shall be as indicated in the below table:

Rooms with White Noise Sensors		
Room Number	Room Name	Zone
G300	HWY OPS CENTER	1
G301	STORM CENTER	2
G302	CONFERENCE ROOM	3
G306	OFFICE	4
G307	OFFICE	5
G305	ENGINEERING	6
G308	COLLAB	6
G311	STORAGE	6
G310	TOILET	6
G309	KITCHEN	6

2.2 LABELS

- A. Except where otherwise specified, label each item of control equipment.
 - 1. Controllers: Constructed of engraved and filled anodized aluminum plates. Minimum 1/8" plate thickness. Dry transfer or other types of adhesive labels not acceptable.
 - 2. Identification Panel: Install panel with 1/8"-high engraved characters.
- B. Identify all wires and cables at every connection point to controllers with reference number keyed to the as-built wiring diagrams.
- C. Room numbers appear on the contract documents for reference only. All labels shall reflect the Owner's final room designations.
- D. Cable Markers:
 - 1. High-grade PVC clip-on or permanent-type cable markers with permanent markings, or printed vinyl tape protected by clear shrink tubing or adhesive wrap or approved equal.

2.3 CONTROLLERS

- E. All sound masking loudspeakers shall be directly powered and managed by a controller.
- F. Controller and zone shall:
 - 1. Have four button control and LCD readout of system settings on front panel.
 - 2. Provide DSP-based sound generation with four (4) uncorrelated masking signal outputs per zone.
 - 3. Have built in signal logic for sequential channel operation by adjacent loudspeakers.
 - 4. Provide pre-set industry standard frequency equalization, specifically tailored to the operating characteristics of the loudspeaker or speakers provided and requiring no frequency equalization during the commissioning process.
 - 5. Provide separate level controls for masking and paging/music adjustable in 1 dB steps over a minimum range of 30 decibels, and off.
 - 6. Have dedicated compressor and peak limiter for paging inputs.
 - 7. Be wall and/or rack mountable (except single zone controllers wall mountable only).
 - 8. Have UL/CUL/CE listed power supply.
 - 9. Be Green Spec-Listed for energy efficiency.
- G. Six-Zone Controllers
 - 1. Network capable management of system acoustic output of all zones.
 - 2. Control software that is pre-installed and resident on controller and accessible via any standard browser from a computer resident on the network.
 - 3. Capability of controlling background sound and paging for up to six separate zones of sound masking with paging selectable by zone, and from one to 120

- speakers per zone covering from 100 to 12,000 square feet per zone or from 100 to 72,000 square feet per controller in 6 zones.
4. Capable of automatic background sound level adjustment (ramping) based on time of day and day of week.
 5. Time source provided by integrated Real Time Clock with battery backup or user selectable SNTP server. Field adjustable using provided Ethernet™ connection and factory installed software.
 6. Dedicated 1/3 octave equalizer covering ISO bands from 200 Hz to 5,000 Hz for background sound spectrum, preset at factory for recommended operation. Field adjustable using provided Ethernet™ connection and factory installed software.
 7. Dedicated 1/1 octave equalizer covering ISO bands from 250 Hz to 8000 Hz for paging input. Field adjustable using provided Ethernet™ connection and factory installed software.
 8. Loudspeaker network fault detection capability.
 9. Two audio inputs (A and B) on rear panel operable in balanced or single ended configuration for distribution of externally generated signals via 4 terminal compression type connectors.
 10. Two contact closure interfaces on rear panel: one turns off masking on closure; one turns off Audio B on closure. May be used to duck masking and/or Audio B during emergency situations.
 11. Minimum Performance Requirements:
 - a. Supply Power: 110 – 240 VAC 0.9 Amperes.
 - b. Rated ambient temperature range: 40 to 90 degrees F (4 to 32 degrees C).
 - c. Output Voltage: 7 volts RMS minimum sine wave at full load, each channel to meet NEC Class 2 requirements for low voltage distribution.
 - d. Audio (paging) input: 600 ohm line bridging, differential or single ended, 1 volt nominal, adjustable between -10 dBv and +4 dBv RMS.

2.4 LOUDSPEAKER

- H. Miniature self-contained ceiling mounted loudspeaker/enclosure/baffle system.
1. Designed specifically for distributing background masking, music, and paging. Ultra wide dispersion to maximize spatial uniformity.
 2. Twist and lock retaining ring construction to minimize installation time in ceiling tiles and enclosures.
 3. All connections via modular RJ45 connectors for plug-and-play installation.
 4. Eye loop for securing unit with safety wire.
 5. UL 2043 certified for plenum installation.
 6. UL approved. Approvals and certifications labeling must be on speakers.
 7. Acceptable Products: Cambridge Sound Management Qt loudspeaker with optional mounting enclosures as follows:
 - a. UB- W(white) or B(black): universal mounting for wooden beam or wall mounting.
 - b. BB-W(white) or B(black): 1" beam clamp mounting for suspended applications.

- c. CM: conduit mounting for sheetrock ceilings.
- d. DM: mounting for sheetrock/drywall ceilings.
- e. PBC: metal plenum back can for use in locations where required by fire code or conduit connectivity.

2.5 LOUDSPEAKER CABLING

- A. Cables terminated with RJ45 modular connectors.
 - 1. Type: CAT3 provided with system: CAT5/5A, CAT6 are compatible.
 - 2. Unshielded solid twisted pair construction; stranded optional.
 - 3. Meet EIA/TIA Standard 568b.
 - 4. Optional AWG #24 stranded conductors with overall plenum-rated jacket (CMP (UL)/C(UL) 4PR 24 AWG Plenum).
- B. Acceptable Products:
 - 1. Cambridge Sound Management pre-assembled 16 foot (4.9 m) or 30 foot (9.1m) Loudspeaker Cable Assembly or approved equal.
 - 2. Site fabricated and tested with overall plenum-rated jacket (CMP (UL)/C(UL) 4PR 24 AWG Plenum).

PART 3 - EXECUTION

3.1 GENERAL

- A. The sound masking system is a delegated design and a full analysis of the space shall be provided as indicated.
- B. All types of equipment installed by competent workers at locations shown on the drawings in strict accordance with approved shop drawings and manufacturer's instructions.
- C. All equipment except portable equipment firmly held in place. This shall include loudspeakers, enclosures, amplifiers, cables, etc. Fastenings and supports adequate to support their loads with a safety factor of at least three unless otherwise stated.
- D. Take such precautions as necessary to prevent and guard against electro-magnetic and electro-static hum and to install the equipment so as to provide safety for the operator.

3.2 LOUDSPEAKERS

- A. Cut hole in center of each ceiling tile using the hole saw provided or similar.
- B. Taking care not to visibly distort tile, slip provided locking collar on back of loudspeaker and firmly tighten against ceiling.

- C. Connect cabling to loudspeakers with system live, starting at controller end of distribution lines. Connect line from output of operating controller set to maximum output to socket designated as input on loudspeaker. Verify operation of each loudspeaker by listening before tile is finally installed in ceiling. If loudspeaker does not operate, fault may be in lines or defective loudspeakers upstream of inoperative unit: correct before continuing. Note that inadvertent connection of line to output of loudspeaker rather than to input will cause some downstream loudspeakers (up to 4 loudspeakers after misconnected unit) to be rendered inoperative.

3.3 LOUDSPEAKER CABLING

- A. Cabling routed within return air plenums shall be plenum-rated unless installed in conduit.
- B. Using a CAT cable tester, test all field fabricated cables, before installation, for open circuits, shorts, crossed pairs, reversed pairs, split pairs and proper pin-out.
- C. Install signal cables secured to ceiling hanger support or building structure per local code and electrical inspector requirements. Cabling shall not contact ceiling tiles or inhibit their removal for access to the plenum. Provide adequate service loop for convenient access to loudspeaker.
- D. Connect no more than 60 loudspeakers/home run.
- E. Install no more than 1000' of cable between Generator/Controller unit and last loudspeaker on each home run.

3.4 SYSTEM TESTS AND ADJUSTMENTS

- A. Initial Test and Adjustments: Perform and record results of the following tests:
 - 1. Loudspeaker Operation: Near field output of each loudspeaker shall match the zone average within +/- 1.5 decibels. Listen directly below each installed loudspeaker to confirm it is operating. For any loudspeakers found to be inoperative, or possibly operating at an incorrect level, use a sound level meter set to A-weighting and slow response to check the output. Place the microphone so as to contact each grille.
 - 2. Replace any defective loudspeakers or cabling, or otherwise correct cause for any loudspeakers found to be operating outside this range.
 - 3. Buzzes, Rattles, and Distortion: With system operating at maximum level, listen for any buzzes, rattles, and objectionable distortion in all areas covered. Correct all causes of these defects.
 - 4. Control Settings: Adjust all spectrum and level controls for normal operation. Measure the A-weighted sound pressure level using a sound level meter set to A-weighting and slow response at representative locations within each zone. Adjust average initial levels in open plan areas to 45 dBA at normal occupants' locations and in closed offices or rooms to 42 dBA.

- B. Demonstrate to the Owner's Representative that the system is fully operable and installed in compliance with the terms of the performance specifications hereunder.
- C. Test the system to demonstrate that the design goal of Privacy Index (PI) = 80% (Normal Privacy) or better is met between representative workstations separated by partitions of 66" or greater height. For this test, select adjacent workstation pairs without direct line of sight or significant sound reflecting ceiling or wall elements between, and with a ceiling material rated at NRC of 0.85 or higher. Tests shall be in accordance with ASTM Standard E1130 except that the octave band calculation method of ANSI Standard S3.5 may be used. Lower levels of PI are acceptable only if the ceiling or partition requirements described hereinbefore are not met.
- D. Test the system in each open plan area zone served to demonstrate that the design goal for spatial uniformity is met. Tests shall be carried out per ASTM Standard E1041 as measured in the 2,000 Hz octave band. At each location, the average sound pressure levels shall be measured over an interval of at least 4 seconds at four positions at 90° intervals around a circle of 0.3 m (1 ft) radius centered on the location. The arithmetic mean sound pressure level shall be calculated from the four measured values. For at least 75% of the test locations, the arithmetic mean sound pressure level in the 2,000 Hz octave band shall not vary by more than 1 dB from the average of the arithmetic mean sound pressure levels measured at all locations.
- E. Test the system to demonstrate that the PI is at least 95% (Confidential Privacy) between representative private (enclosed) offices served by the system. For this test, select adjacent offices with closed doors. Tests shall be in accordance with ASTM Standard E1130 except that the octave band calculation method of ANSI Standard S3.5 may be used. Lower levels of PI are acceptable if the common walls between the offices do not extend to the deck above the acoustical ceiling and the ceiling material is not rated at STC 35 or greater. If the PI achieved is lower than 95% and not caused by these or other architectural factors, the Contractor shall make corrections to the system.

3.5 TRAINING

- A. Refer to Form 817 Article 1.20-1.08.14 subsection 3 for additional information.
- B. Engage a factory-authorized service representative to instruct Owner's personnel in operating and routine maintenance service procedures to be used with the sound masking systems.

END OF SECTION 275119

SECTION 276270 – CENTRAL RADIO SYSTEM

PART 1 - GENERAL

1.1 SUMMARY:

- A. Section includes a complete central radio system including mounting hardware, enclosures, microphones, software, firmware, integration, programming, line balancing, connectors, cables, and accessories.

1.2 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Include installation details, materials description, dimensions of individual components and profiles, finishes, accessories such as enclosures, cables and connectors and wiring diagrams.
- C. Quality Assurance Submittals:
 - 1. Certified results of laboratory tests (If applicable).
 - 2. Radio System Installer Qualifications.
 - 3. Plan to integrate Contract work with the existing radio system.

1.3 CLOSEOUT SUBMITTALS:

- A. Operation and Maintenance Data: For the Central Radio System to include in operation, and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS. Include the following:
 - 1. “As-Built” installation prints.
 - 2. Equipment manuals that include technical information, wiring diagrams and schematics, hook-up prints, parts lists, operating guides, and troubleshooting manuals.

1.4 QUALITY ASSURANCE:

- A. Single Source Responsibility: Obtain each type of required component from a single GAI-Tronics Corp. manufacturer or representative herein known as the Radio System Installer unless otherwise noted.
- B. The Radio System Installer shall have a minimum of 4 years of experience with the existing Gai-Tronics CommandPlus system located in the existing Newington Highway Operations Center.
- C. The Radio System Installer shall provide proof of experience and knowledge for previous project references verifying the qualifications requirements described herein this specification. All references shall include project description, company name, contact name and phone number.
- D. The Radio System Installer shall submit the name and qualifications of the central radio system installer as part of the submittal package prior to installation.

1.5 DELIVERY, STORAGE AND HANDLING:

- A. Do not deliver central radio hardware until video wall Room 0111b is enclosed, other construction within spaces where radio hardware will be installed is substantially complete, and installation of equipment is ready to take place or as directed by the Engineer.
- B. Protect central radio hardware from damage during delivery, handling, storage, and installation.
- C. Store central radio hardware in manufacturer's protective package in a position that complies with manufacturer's directions. Keep equipment in manufacturer's protective packages until time of installation.

PART 2 - PRODUCTS

2.1 GENERAL:

- A. Provide manufacturer's standard units complying with the requirement indicated for the various hardware components. Along with the units described below, the Radio System Installer shall furnish all necessary cables and connectors. Cables shall be of adequate length so that all equipment can be installed as shown on the plans. All connection cables shall conform to the manufacturer's recommendations.
- B. All equipment shall be GAI-Tronics CommandPLUS Dispatch Consoles Model ICP9012A connecting to the existing GAI-Tronics radio equipment. All termination

panels and connections shall be The Siemon Company. The GAI-Tronics CommandPLUS Dispatch Consoles Model ICP9012A shall include the minimum:

- 12 Channel Control
- 4 Channel Expansion Kits Support System Growth
- Accommodates 10 Consoles per System
- Supports Tone, DC and E&M Control Types
- Stack Paging
- One-Button Paging
- Multi-Channel Sequential Group Paging
- Multiple Alert Tones (4)
- Alert Page
- Multi-Channel Radio Patch
- Paging Encoder for Individual or Group Paging
- DTMF Decode for Automatic Number Identification
- Full-Duplex Telephone Interface Capability
- Select Channel Volume Control
- Programmable Channel Buttons
- Adjustable Alert and Paging Tones
- Added Program Security
- Enhanced Multi-Tasking Operation
- Supports Headset, Gooseneck Mic, Desk Mic and Footswitch
- Easy to use Windows® based Programming Application
- Audio Output to Logging Voice Recorder
- MDC1200 Option

C. All termination equipment below shall be The Siemon Company:

- Pre-wired M4 series modular blocks
- Telephone network interface block
- Back mounted connectors
- Cable management and strain relief
- Hinge covers
- Labels

D. No “approved equals” will be accepted.

2.2 CENTRAL RADIO SYSTEM:

A. The central radio system shall include the following Gai-Tronics products:

<u>ITEM</u>	<u>QTY</u>	<u>DESCRIPTION</u>
A.	9	ICP9012A Gai-tronics 12 Channel, 4 input CommandPlus Desktop Consoles.
B.	9	XCP0030A Gai-tronics 25 pair Telco interface

		kits.
C.	9	XMD003A Gai-tronics Gooseneck Desk Microphones.
D.	3	XCP0170A Gai-tronics Programming cables
E.	2	Spare XCP0030A Gai-tronics 25 pair Telco interface kits used for bridging 8 of the 9 Consoles to the 1 Console terminated to phone line
F.	12	<p>i. 25-Pair Cat 3, plenum rated console control cable where a cable jumper or additional console has a dedicated cable run from the Conference Closet to console floor box in the plans shown on the plans.</p> <p>ii. 25-Pair Cat 3, min. 15 ft. plenum rated console control cable connected from ICP9012A Gai-tronics 12, 4 input Channel CommandPlus Desktop Consoles to each console floor box.</p> <p>iii. (1) 600 ohm diode for bridging (8) ICP9012A Gai-tronics 12 Channel, 4 input CommandPlus Desktop Consoles to (1) ICP9012A Gai-tronics 12 Channel, 4 input CommandPlus Desktop Console.</p> <p>iv. Plenum rated tie wraps.</p>
G.	5	The Siemon Company 66 block punch downs

PART 3 - EXECUTION

3.1 COORDINATION:

- A. Coordinate installation of central radio system with other construction supported by or penetrating through, ceiling, flooring, furniture relocation, HVAC equipment, fire-suppression equipment and partitions.
- B. Coordinate connection of central radio system to the telephone circuit in the telecommunications room with Engineer. Coordinate the line balancing of the Central Radio System with Engineer. Coordination of the telephone circuit connection and line balancing shall include CTDOT radio specialist.

3.2 INSTALLATION:

- A. General: The central radio system hardware shall be installed at those locations shown on the plans.
- B. All equipment shall be installed and configured in accordance with the details shown on the plans or as noted and in accordance with manufacturer's installation instructions.

- C. The Radio System Installer shall install all cabling required between the central radio system equipment specified herein as well as all necessary cabling to integrate the central radio equipment specified herein with the existing central radio equipment. The contractor shall neatly bundle all CAT 3 cables and tie down to the under floor cable troughs. CAT3 cables that pass through floor box locations at each operator console shall have 8 feet of neatly coiled cable slack under the raised floor to accommodate potential future room configuration changes.
- D. The Radio Systems Installer shall connect 12 individual CAT 3 cables from the Comm. Closet G318 to the floor box for each operator work station including the storm room without any intermediate splices or connectors. The Radio System Installer shall install a Cat 3 minimum 15 feet cable from the floor box to the GIA-tronics consoles using male to female D-sub connectors of the type used to connect the CAT 3 cable to the GIA-tronics consoles. The cable connections in the floor box shall be secured using D-sub screws. The cable connecting to the consoles shall be capable of moving unimpeded with the sit-to-stand consoles.
- E. The Radio Systems Installer shall terminate and connect 12 individual CAT 3 25 pair cables from the consoles to The Siemon Company 66 block punch downs in Communications Closet G318.
- F. The Radio Systems Installer shall connect all radio channels from the 200 pair Cat 3 cable installed from the telecommunications room G201 to the communications closet G318.
- G. In the communications closet G318, the Radio System Installer shall bridge, connect, configure, program, integrate 8 of the 9 console units to a single console unit at the termination block. The single console unit shall be connected to the bridge telephone circuit. The (1) 600 ohm diode shall be included in the (9) console bridge connection. The Radio Systems Installer shall receive approval from the Engineer for the location and configuration of the diode connection. The bridge console unit shall be connected to all radio channels as directed by the Engineer.
- H. The Radio System Installer shall relocate equipment and cables as shown on the plans or as directed by the Engineer. The Radio System Installer shall remove the existing Gai-Tronics CommandPlus 0111D and turn it over to the Engineer as salvage.
- I. The Radio System Installer shall maintain the existing Gai-Tronics central radio system during the central radio system upgrade.

3.3 TESTING:

- A. The Radio System Installer shall perform a functional test to demonstrate to the Engineer a proper installation and system functionality. Upon successful completion of this test the Central Radio System shall be connected temporarily to each radio channel. The contractor shall coordinate the temporary connection to each radio channel with the CTDOT radio specialist.

- B. The Radio System Installer shall perform a performance test in accordance with manufacturer's requirements and as described herein. The Radio System Installer shall test each radio channel at each radio station shown on the plans. The Radio System Installer shall test for line loss at each radio station. The Radio System Installer shall test for line balancing for each console unit and channel. The Radio Systems Installer shall test all consoles operation with telephone circuit. All configuration, programming, integration and line balance test results shall be provided and coordinated with CTDOT radio specialist.
- C. Upon successful completion of the performance test, the Radio System Installer shall perform 30 Day System Operational Test on the Central Radio System. The Radio System Installer shall coordinate this test with other pertinent Contract work.
 - 1. The System Operational Test shall consist of a complete and fully operational central radio system. During the course of this test, the system must function continuously in accordance with the Contract for the duration of the test.
 - 2. If a malfunction occurs within the stated time frame, then the Radio System Installer shall make all necessary repairs to the system.
 - 3. After repairs, the System Operational Test will begin anew. The system shall operate a full 30 consecutive days without a malfunction before the system will be accepted by the Engineer.
- D. Any performance requirement discrepancy shall be regarded as failures and shall be documented and diagnosed by the Radio System Installer. If the problem is hardware-oriented, then the Radio System Installer shall remove the failed unit and replace it with a new unit with no additional cost to the State. If the problem is software-oriented, then the Radio System Installer shall promptly notify Engineer of the problem. The Radio System Installer shall be responsible for all work delays caused by failed equipment.

3.4 PROTECTION AND CLEANING:

- A. Protect central radio system hardware after installation from damage during construction. If despite such protection, damage does occur, remove and replace damaged components or entire unit as required to provide units in their original undamaged condition.
- B. Clean all components immediately prior to date schedules for inspection intended to establish date of Substantial Completion. Use methods of cleaning and cleaning materials recommended by the equipment manufacturer taking care not to damage monitor screens or projection lenses.

3.5 TRAINING:

- A. Refer to Form 817 Article 1.20-1.08.14 subsection for additional information.
- B. The Radio System Installer shall provide 7 hours of training on the setup and configuration of the central radio system.

END OF SECTION 276270

SECTION 281300 - ACCESS CONTROL

1.1 QUALITY ASSURANCE

- A. **Installer Qualifications:** Installer shall have a minimum of 10 years' experience in the installation, integration and maintenance of Access Control Systems (ACS), and shall be approved and certified by the manufacturer in the installation, configuration and maintenance of the existing Northern computers ACS. Services shall include the installation, configuration, testing and licensing required for full and complete installation and integration of the new access control points with the existing legacy ACS.
- B. **Quality Standards:** The installation and termination of all wiring, cabling, ACS panels, power supplies and associated hardware and devices shall be in conformance with industry best practices, and all current UL, NEC and where applicable, BICSI standards.

1.2 DESCRIPTION OF WORK

- A. **Expand the existing Northern Computers PC-based Access Control System.**
 - 1. Furnish labor, materials and equipment necessary for installation, connection, system configuration, commissioning and turnover of five (5) new operational access control points.
 - 2. Equipment and materials shall include but not be limited to field controllers, card readers, door position switches, motion detectors, low voltage power supplies, wire and cable.
 - 3. Coordinate the installation with the Door Hardware specification section. Electrified door hardware will be furnished by others.
 - 4. Furnish material and labor required for connection of the field controller and low voltage power supplies to a 120VAC source.
 - 5. Furnish connection of the Lock Power Supply to the Fire Alarm System, for doors in the path of egress.
 - a. Coordinate the work with Specification Section 283100-Fire Alarm System.
- B. **Communications**
 - 1. Furnish the required connectivity wire and cable, modules and connectors to enable communications between the field controller and PC.
- C. **System Configuration:**
 - 1. Provide the services necessary to configure the software application in the ACS in order to integrate the operation of the new access control points into the system. Include all services to enable the system features utilized for existing doors on the new doors.
 - a. Integrate the new access control points into the existing system database.
 - b. Configure the alarm point scheduling of each door.
 - c. Configure the card holder access permissions and scheduling for each door as per the owner's requirements.
 - d. Configure the new points in map displays, if used in the existing ACS.
 - 2. Furnish and install software in the existing ACS, as required to expand the system capacity to accept the additional doors. If such increases in system capacity are required to accept the new doors, furnish software upgrades to include capacity for additional system

expansion at the completion of the installation. The additional system capacity shall be no less than the unused capacity of the field controller furnished under this contract to accept the new access control points.

1.3 OPERATION

- A. Maintain the existing ACS operation throughout installation and configuration of the system.
 - 1. In the event it is necessary to interrupt system operations, owner approval is required prior to system operation interruption. Coordinate the timing and duration of the required outages with the owner. Proceed with activities related to the system operation only with the owner's approval.
- B. Field Devices and Interface Equipment.
 - 1. All equipment is to be installed in accordance with manufacturer specifications and industry best practices.

1.4 APPLICATION SOFTWARE

- A. Furnish upgrades to the ACS software, as required to provide a fully functional system.
- B. System Software
 - 1. System licenses
 - 2. Application software.
 - 3. Workstation software.
 - 4. Controller software.
 - 5. PC-to-controller communications.

1.5 SYSTEM DATABASE

- A. Database and Database Management Software:
 - 1. Define and configure each point in the ACS database.
 - a. Definition shall include parameters and constraints associated with each system device to the extent that they are defined for existing access controlled portals.

1.6 HARDWARE

- A. Furnish surge protection as per the manufacturer's specifications and tamper protection for equipment cabinets.
- B. Controllers: Intelligent peripheral control unit:
 - 1. Compatible with existing ACS system and field equipment
 - 2. Support for 16 card readers as furnished.
 - 3. Expandable to 32 card readers per enclosure.
- C. Card Readers:
 - 1. Proximity readers. HID Prox Pro or equivalent, to match existing card readers. Installer to verify manufacturer and model of existing hardware.

- 2. Request-to-Exit Motion Sensors: Bosch DS-150i PIR or equivalent.
- D. Door Position Switch.
 - 1. DPS: GE / Sentrol 2507AH-L or equivalent.
- E. Low Voltage Power Supply (LVPS)
 - 1. 24VDC LVPS for the support of the electrified locking devices: Altronix AL1024ULACMCB or equivalent (NOTE supports individually selectable FACP outputs)
 - 2. 12VDC LVPS for support of the Request-to-Exit motion detectors: Altronix AL102ULXPD8 or equivalent.
- F. Door Hardware Interface:
 - 1. Electric door strikes by others.
- G. Cables: NFPA 70, Types CM, CMP, CMG, and CMR; multi-conductor, jacketed, to conform to the ACS manufacturer specified cabling.
- H. Cable Management:
 - 1. All cabling shall be properly labelled using permanent, self-adhesive tags with indelible markings.
 - 2. Cabling shall utilize existing pathways as much as possible; if no existing path is available vendor must submit drawings of proposed hangers for approval.

1.7 INSTALLATION

- A. Wiring Method:
 - 1. All cabling and wiring shall be properly secured within raceway and cable tray except within cabinets [and in accessible ceiling spaces and gypsum board partitions].
 - 2. All cabling installed beneath raised / computer floors shall have a minimum eight (8) foot long service loop.

1.8 FIELD QUALITY TESTING

- A. Test Procedure: Installer shall develop a Test and Acceptance Plan (TAP) to fully test and verify each installed component, cable and termination; TAP shall be approved by system owner and engineer.

END OF SECTION 281300

SECTION 282300 - VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 SUMMARY:

- A. Section includes video surveillance system within the Library (ground floor) and tied into the existing security system in the Security Office on the first floor.

1.2 DEFINITIONS:

- A. NTSC: National Television System Committee.
- B. POE: Power over Ethernet

1.3 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
- C. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.
 - 1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
 - 2. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
 - 3. Wiring Diagrams: Power, signal, and control wiring, and grounding.
- D. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For cameras, power supplies, monitors, video switches, and control-station components to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08-14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE:

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NECA 1.
- C. Comply with NFPA 70.
- D. Electronic data exchange between video surveillance system shall comply with SIA TVAC.

1.5 PROJECT CONDITIONS:

- A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
 - 1. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. NEMA 250, Type 1 enclosures.

1.6 WARRANTIES:

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS for additional information.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, and control-station equipment that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from the issuance of the Certificate of Compliance.

PART 2 - PRODUCTS

2.1 CAMERAS:

- 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. Avigilon.
 2. Bosh Security Systems.
 3. Panasonic Security Systems.
- B. Camera: Dome Camera with ceiling mounting bracket. Bosh FLEXIDOME IP indoor 4000i or approved equal.
1. Suitable for interior environment.
 2. Comply with UL 60950.
 3. Power Source: POE IEEE802.3af Class 3 Compliant
 4. Active Pixels: 1920 (H) x 1080 (V). (1080p30)

2.2 SIGNAL TRANSMISSION COMPONENTS:

- A. Switch: NETGEAR GS305P 5-Port with 4-Port POE Gigabit Ethernet Switch or approved equal. Include mounting hardware.
- B. Cable: Cable shall be black, UL listed, Category 6 certified cable, plenum rated. Homerun shall be with no splices. Cable shall be four (4) pair, 100 Ohms unshielded twisted pair.
1. From the Library to the Switch in Communications Closet G318: CAT 6.
 2. From Switch to First Floor: Plenum-rated CAT 6.

2.3 SYSTEM REQUIREMENTS:

- A. Video signal format shall comply with the NTSC standard digital video, progressive.

PART 3 - EXECUTION

3.1 WIRING:

- A. Wiring Method: Install cables in unfinished spaces above ceiling or in raceway in locations indicated.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- C. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.2 VIDEO SURVEILLANCE SYSTEM INSTALLATION:

- A. Install cameras level and plumb.
- B. Install cameras as shown on plans. Change type of mounting to achieve required clearance.
- C. Install power supplies and other auxiliary components at control stations, unless otherwise indicated.
- D. Identify system components, wiring, cabling, and terminals according to CSI Division 26 Section 260553, "Identification of Electrical Systems."

3.3 FIELD QUALITY CONTROL:

- A. Verify and inspect installation with existing security system Siemens representative.
- B. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
- C. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video surveillance equipment for acceptance and operational testing as follows:
 - 1. Verify operation of auto-iris lenses.
 - 2. Set and name all preset positions; consult Owner's personnel.
 - 3. Verify operation of control-station equipment.
- D. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 calendar days. Provide a minimum of 10 calendar days' notice of test schedule.
- E. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- F. Remove and replace malfunctioning items and retest as specified above.
- H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.4 CLEANING:

- A. Clean installed items using methods and materials recommended in writing by manufacturer.

- B. Clean video surveillance system components, including camera-housing windows, lenses, and monitor screens.

END OF SECTION 282300

SECTION 283100 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY:

- A. Furnish and install Fire Alarm Devices and modify existing Fire Alarm System as described herein utilizing an addressable control panel, and as shown on the plans; to be wired, connected, and left in first-class operating condition. The system shall use addressable loop initiating device circuits with individual supervision, individual indicating appliance circuit supervision, incoming and standby power supervision. The fire alarm system shall include manual pull stations, automatic fire (smoke and heat) detectors, and audio/visual devices (horns and strobes). All wiring, connections to devices, outlet boxes, junction boxes, and all other necessary material for a complete operating system shall be included. All conductors for the fire alarm system shall be routed in conduit.
- B. All panels and peripheral devices shall be the standard product of a single manufacturer and shall display the manufacturer's name on each component. The entire system shall bare the appropriate UL listing.

1.2 SYSTEM DESCRIPTION:

- A. Fire alarm system shall be FM Global approved and shall be installed in accordance to FM Global Data Sheet 5-40 and 5-48.
- B. The System shall consist of initiating devices and indicating appliances wired to the fire alarm panel. The System shall generate audible alarms throughout all signal horns and signal lamps shall flash continuously throughout the building at the activation of any of the fire detectors, until manually reset. A signal shall be generated to report the troubled condition to the respective authorities.

1.3 OPERATION:

- A. The System alarm operation subsequent to the alarm activation of any manual station or automatic detection device shall be to cause an alarm condition at the central panel. Central panel shall contain a dialer to alert local fire authorities in the event of alarm activation.
- B. The alarm and/or trouble condition shall be indicated on the remote 80-character annunciator panel. Indicate the device in alarm on the fire control panel and the remote annunciator.

- C. Alarm horns and indicating appliances shall be activated by the alarm condition at the central panel. Weatherproof fire alarm horn with strobes shall be installed in such a manner that it is visible from the access road.
- D. The operation of the system shall be in compliance with all applicable fire alarm codes.

1.4 SUPERVISION:

- A. The system shall contain Class 'A' independently supervised initiation circuits so a fault in any one area shall not affect any other zone. The alarm activation of any initiation circuit shall not prevent the subsequent alarm operation of any other initiation circuit. Wiring for the signal line circuit shall be twisted unshielded and support a minimum wiring distance of 12,500 feet. Number and size of conductors shall be as recommended by the manufacturer of the fire alarm system but not less than 18 AWG for initiating device circuits and signaling line circuits. All fire alarm system conductors shall be installed in conduit, unless otherwise noted.
- B. There shall be independently supervised and independently fused indicating appliance circuits for alarm horns and flashing alarm lamps.
- C. All auxiliary manual controls shall be supervised so that all switches must be returned to the normal automatic position to clear system trouble.
- D. Each independently supervised circuit shall indicate on the 80-character display "Trouble" to indicate disarrangement conditions per circuit. Each junction box capacity shall be 40 percent greater than that required for associated fire alarm system wires. Each junction box shall be painted fire alarm red and identified with white markings "FIRE ALARM SYSTEM."
- E. The incoming power to the system shall be supervised so that any power failure shall be audibly and visually indicated at the control panel. A green "POWER ON" LED shall be displayed continuously while incoming power is present.
- F. The system batteries shall be supervised so that disconnection of a battery shall be audibly and visually indicated at the control panel. Final connections between equipment and wiring system shall be made under supervision of the manufacturer's representative. Fire alarm equipment shall be flush to surface wherever possible.
- G. The System Expansion Modules connected by ribbon cables shall be supervised for module placement. Should a module become disconnected from the CPU the system trouble indicator shall illuminate and audible trouble signal shall sound.
- H. Wires for local fire alarm system shall be color-coded to correspond with manufacturers' wiring schematics submitted with shop drawings, sized as recommended by the fire alarm system manufacturer and installed in conduit. Combined cross sectional area of conductors or cables shall not exceed percentage of fill specified in

Table 1, Chapter 9 of NEC. Conduit size shall be coordinated with fire alarm manufacturer.

1.5 POWER REQUIREMENTS:

- A. The Fire Alarm Control Panel shall receive 120 VAC power (primary source of power as noted on the plans) via a dedicated circuit breaker. The secondary source of power (standby source) is a generator in conjunction with the fire alarm system standby battery and charger.
- B. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of four (4) hours with ten (10) minutes of alarm indication at the end of this period. The system shall automatically transfer to the emergency diesel generator in conjunction with standby batteries upon power failure. All battery charging and recharging operations shall be automatic. Batteries, once discharged, shall recharge at a rate to provide a minimum of 70% capacity in 12 hours.
- C. All circuits requiring system-operating power shall be 24VDC and shall be individually fused at the control panel.

1.6 SUBMITTALS:

- A. Submit the following in accordance with Form 817 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Manufacturer's catalog sheets, specifications, and installation instructions.
 - 1. Include name, address, and telephone number of in-state supplier of spare parts. No out-of-state suppliers shall be permitted.
- C. Shop Drawings: CADD generated composite wiring and schematic diagrams, produced and stamped by Supplier, of the complete system as proposed to be installed. Include battery-size calculations sheet.
- D. Quality Assurance Submittals:
 - 1. Name, address and telephone number of nearest fully equipped service organization.
 - 2. Test Reports: Final System test report.
 - 3. Certificate: Affidavit, signed by the approved supplier and notarized, certifying that the system meets the Contract requirements and is operating properly.
- E. Maintenance Data: For fire alarm system to include in the operation and maintenance manuals specified in Form 817 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – OPERATION AND MAINTENANCE MANUALS.

- F. Warranty: Special warranties specified in Part 1.9, "Warranty."

1.7 QUALITY ASSURANCE:

- A. Each and all items of the Fire Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer under the appropriate category by the Underwriters' Laboratories, Inc. (UL) and shall bear the "UL" label. All control equipment shall be listed under UL category UOJZ as a single control unit. Partial listing shall NOT be acceptable.
- B. In addition to the UL-UOJZ requirement listed above, the system controls shall be UL listed for Power Limited Applications per NEC 760. All circuits must be marked in accordance with NEC article 760-23.
- C. The complete installation shall conform to the applicable sections of NFPA-72 A through H, Local Code Requirements and NEC Code Article 760.
- D. The fire alarm system shall be UL listed and in accordance with all applicable documents.
- E. Installation and commissioning technicians shall be factory trained within the last two years on the specific equipment listed for the project.
- F. Installation and commissioning technicians shall be NICET Level II or above for fire alarm technology. Technicians' names and certificate number shall be provided for this particular project as part of the submittal process.
- G. Manufacturers shall have a minimum of five years experience in the design, manufacture, and maintenance of fire alarm equipment.
- H. Local service agency shall have a minimum of \$10,000 of spare parts and be within 50-mile radius of the Project Site. Name and address of service agency along with location of spare parts inventory shall be furnished as part of submittal process.

1.8 SPARE PARTS:

- A. Furnish to the Engineer spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fifty percent spare of each type fuse.
 2. Thirty percent spare of each type lamp (except LED).
 3. Ten percent spare of each item requiring replacement for operation and routine maintenance of system, but not less than two of each type for component.

1.9 WARRANTIES:

- A. Refer to Form 817 Article 1.20-1.06.08 and NOTICE TO CONTRACTOR – WARRANTIES for additional information.
- B. The equipment manufacturer shall make available to the Engineer a maintenance contract proposal to provide a minimum of two (2) inspections and tests per year in compliance with NFPA-72H guidelines.
- C. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period.
- D. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, all the equipment shall be the product of Siemens.

Siemens Industry, Inc. – Product Line: Siemens Fire Alarm (Existing Base Building and Basis of Design)

Point of contact:

Michael Garala

Mobile: (860) 306-8381

Email: Michael.garala@siemens.com

No “Or Equals” will be considered.

2.2 PERIPHERAL DEVICES - FIRE ALARM SYSTEM:

- A. Manual Pull Stations:

- 1. Addressable manual stations shall be single action and shall be constructed of high impact, red Lexan with raised white lettering and a smooth high gloss finish. The station shall have a hinged front with key lock. Stations which utilize screwdrivers, Allen wrenches, or other commonly available tools shall not be accepted. Stations shall be keyed alike with the Fire Alarm Control Panel. When the station is

operated, the handle shall lock in a protruding manner to facilitate quick visual identification of the activated station.

B. Smoke Detectors:

1. Addressable smoke detectors shall be photoelectric type UL 268 listed. The detectors shall have a functional test feature that simulates smoke.
2. Each detector shall have a flashing status indicating LED for visual supervision. When the detector is actuated, the flashing LED will latch on steady and at full brilliance. The detector may be reset by actuating the control panel reset switch.
3. To minimize nuisance alarms, voltage and RF transient suppression techniques shall be employed as well as a smoke verification circuit and an insect screen. The detector design shall provide full solid-state construction and compatibility with other normally open fire alarm detection loop devices (heat detectors, pull stations, etc.). The detector head shall be easily disassembled to facilitate cleaning.

C. Audio Visual Alarm Unit:

1. Audio Visual units shall be made of red impact resistant and flame retardant thermoplastic injection molded frame with a xenon strobe lamp. The assemblies shall be flush mounted to a 4 inch square electrical box. The white Lexan lens shall have the word 'FIRE' in red lettering on the front. Alarm horns shall be polarized and shall be operated by 24 VDC. Each horn assembly shall include separate terminals for in/out wiring for each leg of the associated signal circuit. T-tapping of signal device conductors to signal circuit conductors shall NOT be accepted. The alarm horns shall be suitable for front mounting on audio-visual assemblies.

D. Visual Flashing Lamps (Xenon Strobe):

1. Visual indicating appliances shall be comprised on a Xenon flashtube and be entirely solid state. These devices shall be UL listed and be capable of wall mounting. The Lexan lens shall be rectangular in shape to allow better visibility.
2. The ADA guidelines specify strobe intensity of 75 candela at 50 feet from the appliance. Although strobe intensity requirements of ADA & NFPA 72 differ, these can be resolved by comparing the strobe coverage of UL-1971 and applying 'equivalent facilitation'.

E. Duct Smoke Detectors:

1. Addressable air duct smoke detectors shall consist of a standard photoelectric detector, two air sampling tubes, and a sampling chamber, capable of detecting the products of combustion. The two tubes shall provide a means for obtaining a sample of air in the duct. A pressure differential shall cause air to be pulled through the first sampling chamber which contains the photoelectric detector. Air shall return from the chamber to the duct through the second tube. Sensitivity shall be field adjustable in accordance with UL 268. The air duct smoke detectors shall each

include form "C" contacts and a remote LED alarm light complete with necessary box, etc. for remote surface mounting. The remote LED shall be wired for manual reset. Duct smoke detectors shall be provided with test stations. Locations of test stations are shown on the plans.

F. Heat detectors: Comply with UL 521

1. Heat Detector, adjustable temperature type: Actuated by temperature that exceeds a set temperature from 135 deg F to 190 deg F. Provide adapter plate for outlet box mounting. The integral addressable module shall be arranged to communicate the detector's status (normal, alarm, trouble).

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Provide and install complete & operable system in accordance with the plans, specifications, all applicable codes, and manufacturer's recommendations. All wiring for the Fire Alarm section shall be in a completely separate conduit system. All junction boxes shall be sprayed red and labeled "FIRE ALARM". Wiring color codes shall be maintained throughout the installation.
- B. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate Installers. All applicable Installers (Sprinkler System, Fire Alarm System, BAS/ATC System, etc.) shall be present at the same time for connections to other building systems.
- C. The manufacturer's authorized representative shall provide onsite supervision of installation.
- D. Clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of installation and must meet all qualifications regarding certification and training as listed.

3.2 TESTING:

- A. The completed fire alarm system shall be fully tested in accordance with NFPA-72H by the Installer in the presence of the Engineer's representative. Upon completion of a successful test, the Installer shall provide a certified test report to the Engineer.

3.3 TRAINING:

- A. Refer to Form 817 Article 1.20-1.08-14 subsection 3 for additional information.

- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the fire detection and alarm system.

END OF SECTION 283100

PERMITS AND/OR REQUIRED PROVISIONS

The following Permits and/or and Required Provisions follow this page are hereby made part of this Contract.

- **PERMITS AND/OR PERMIT APPLICATIONS**

No Permits are required for this contract

- **Construction Contracts - Required Contract Provisions (FHWA Funded Contracts)**

Construction Contracts - Required Contract Provisions (FHWA Funded Contracts)

Index

1. Federal Highway Administration (FHWA) Form 1273 (Revised May 1, 2012)
2. Title VI of the Civil Rights Act of 1964 / Nondiscrimination Requirements
3. Contractor Work Force Utilization (Federal Executive Order 11246) / Specific Equal Employment Opportunity
4. Requirements of Title 49, CFR , Part 26, Participation by DBEs
5. Contract Wage Rates
6. Americans with Disabilities Act of 1990, as Amended
7. Connecticut Statutory Labor Requirements
 - a. Construction, Alteration or Repair of Public Works Projects; Wage Rates
 - b. Debarment List - Limitation on Awarding Contracts
 - c. Construction Safety and Health Course
 - d. Awarding of Contracts to Occupational Safety and Health Law Violators Prohibited
 - e. Residents Preference in Work on Other Public Facilities (Not Applicable to Federal Aid Contracts)
8. Tax Liability - Contractor's Exempt Purchase Certificate (CERT – 141)
9. Executive Orders (State of CT)
10. Non Discrimination Requirement (pursuant to section 4a-60 and 4a-60a of the Connecticut General Statutes, as revised)
11. Whistleblower Provision
12. Connecticut Freedom of Information Act
 - a. Disclosure of Records
 - b. Confidential Information
13. Service of Process
14. Substitution of Securities for Retainages on State Contracts and Subcontracts
15. Health Insurance Portability and Accountability Act of 1996 (HIPAA)
16. Forum and Choice of Law
17. Summary of State Ethics Laws

18. Audit and Inspection of Plants, Places of Business and Records
19. Campaign Contribution Restriction
20. Tangible Personal Property
21. Bid Rigging and/or Fraud – Notice to Contractor
22. Consulting Agreement Affidavit
23. Federal Cargo Preference Act Requirements (46 CFR 381.7(a)-(b))

Index of Exhibits

- EXHIBIT A – FHWA Form 1273 (Begins on page 14)
- EXHIBIT B – Title VI Contractor Assurances (page 35)
- EXHIBIT C – Contractor Work Force Utilization (Federal Executive Order 11246) / Equal Employment Opportunity (page 36)
- EXHIBIT D – Health Insurance Portability and Accountability Act of 1996 (HIPAA) (page 43)
- EXHIBIT E - Campaign Contribution Restriction (page 51)
- EXHIBIT F – Federal Wage Rates (Attached at the end)
- EXHIBIT G - State Wage Rates (Attached at the end)

1. Federal Highway Administration (FHWA) Form 1273

The Contractor shall comply with the Federal Highway Administration (FHWA), Form 1273 attached at Exhibit A, as revised, which is hereby made part of this contract. The Contractor shall also require its subcontractors to comply with the FHWA – Form 1273 and include the FHWA – Form 1273 as an attachment to all subcontracts and purchase orders.

2. Title VI of the Civil Rights Act of 1964 / Nondiscrimination Requirements

The Contractor shall comply with Title VI of the Civil Rights Act of 1964 as amended (42 U.S.C. 2000 et seq.), all requirements imposed by the regulations of the United States Department of Transportation (49 CFR Part 21) issued in implementation thereof, and the Title VI Contractor Assurances attached hereto at Exhibit B, all of which are hereby made a part of this Contract.

3. Contractor Work Force Utilization (Federal Executive Order 11246) / Equal Employment Opportunity

- (a) The Contractor shall comply with the Contractor Work Force Utilization (Federal Executive Order 11246) / Equal Employment Opportunity requirements attached at Exhibit C and hereby made part of this Contract, whenever a contractor or subcontractor at any tier performs construction work in excess of \$10,000. These goals shall be included in each contract and subcontract. Goal achievement is calculated for each trade using the hours worked under each trade.
- (b) Companies with contracts, agreements or purchase orders valued at \$10,000 or more will develop and implement an Affirmative Action Plan utilizing the ConnDOT Affirmative Action Plan Guideline. This Plan shall be designed to further the provision of equal employment opportunity to all persons without regard to their race, color, religion, sex or national origin, and to promote the full realization of equal employment opportunity through a positive continuation program. Plans shall be updated as required by ConnDOT.

4. Requirements of Title 49, Code of Federal Regulations (CFR), Part 26, Participation by DBEs

Pursuant to 49 CFR 26.13, the following paragraph is part of this Contract and shall be included in each subcontract the Contractor enters into with a subcontractor:

“The Contractor, subrecipient or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR Part 26, Participation by DBEs, in the award and administration of U.S. DOT-assisted contracts. Failure by the Contractor to carry out these requirements is a material breach of this Contract, which may result in the termination of this contract or such other remedy as ConnDOT (recipient) deems appropriate.”

5. Contract Wage Rates

The Contractor shall comply with:

The Federal and State wage rate requirements indicated in Exhibits F and G hereof, as revised, are hereby made part of this Contract. The Federal wage rates (Davis-Bacon Act) applicable to this Contract shall be the Federal wage rates that are current on the US Department of Labor website

(<http://www.wdol.gov/dba.aspx>) as may be revised 10 days prior to bid opening. These applicable Federal wage rates will be physically incorporated in the final contract document executed by both parties. The Department will no longer physically include revised Federal wage rates in the bid documents or as part of addenda documents, prior to the bid opening date. During the bid advertisement period, bidders are responsible for obtaining the appropriate Federal wage rates from the US Department of Labor website.

To obtain the latest Federal wage rates go to the US Department of Labor website (link above). Under Davis-Bacon Act, choose "Selecting DBA WDs" and follow the instruction to search the latest wage rates for the State, County and Construction Type. Refer to the Notice to Contractor (NTC) - Federal Wage Determinations (Davis Bacon Act).

If a conflict exists between the Federal and State wage rates, the higher rate shall govern.

Prevailing Wages for Work on State Highways; Annual Adjustments. With respect to contracts for work on state highways and bridges on state highways, the Contractor shall comply with the provisions of Section 31-54 and 31-55a of the Connecticut General Statutes, as revised.

As required by Section 1.05.12 (Payrolls) of the State of Connecticut, Department of Transportation's Standard Specification for Roads, Bridges and Incidental Construction (FORM 816), as may be revised, every Contractor or subcontractor performing project work on a Federal aid project is required to post the relevant prevailing wage rates as determined by the United States Secretary of Labor. The wage rate determinations shall be posted in prominent and easily accessible places at the work site.

6. Americans with Disabilities Act of 1990, as Amended

This provision applies to those Contractors who are or will be responsible for compliance with the terms of the Americans with Disabilities Act of 1990, as amended (42 U.S.C. 12101 et seq.), (Act), during the term of the Contract. The Contractor represents that it is familiar with the terms of this Act and that it is in compliance with the Act. Failure of the Contractor to satisfy this standard as the same applies to performance under this Contract, either now or during the term of the Contract as it may be amended, will render the Contract voidable at the option of the State upon notice to the contractor. The Contractor warrants that it will hold the State harmless and indemnify the State from any liability which may be imposed upon the State as a result of any failure of the Contractor to be in compliance with this Act, as the same applies to performance under this Contract.

7. Connecticut Statutory Labor Requirements

(a) Construction, Alteration or Repair of Public Works Projects; Wage Rates. The Contractor shall comply with Section 31-53 of the Connecticut General Statutes, as revised. The wages paid on an hourly basis to any person performing the work of any mechanic, laborer or worker on the work herein contracted to be done and the amount of payment or contribution paid or payable on behalf of each such person to any employee welfare fund, as defined in subsection (i) of section 31-53 of the Connecticut General Statutes, shall be at a rate equal to the rate customary or prevailing for the same work in the same trade or occupation in the town in which such public works project is being constructed. Any contractor who is not obligated by agreement to make payment or contribution on behalf of such persons to any such employee welfare fund shall pay to each mechanic, laborer or worker as part of such person's wages the amount of payment or contribution for such person's classification on each pay day.

(b) Debarment List. Limitation on Awarding Contracts. The Contractor shall comply with Section 31-53a of the Connecticut General Statutes, as revised.

(c) Construction Safety and Health Course. The Contractor shall comply with section 31-53b of the Connecticut General Statutes, as revised. The contractor shall furnish proof to the Labor Commissioner with the weekly certified payroll form for the first week each employee begins work on such project that any person performing the work of a mechanic, laborer or worker pursuant to the classifications of labor under section 31-53 of the Connecticut General Statutes, as revised, on such public works project, pursuant to such contract, has completed a course of at least ten hours in duration in construction safety and health approved by the federal Occupational Safety and Health Administration or, has completed a new miner training program approved by the Federal Mine Safety and Health Administration in accordance with 30 CFR 48 or, in the case of telecommunications employees, has completed at least ten hours of training in accordance with 29 CFR 1910.268.

Any employee required to complete a construction safety and health course as required that has not completed the course, shall have a maximum of fourteen (14) days to complete the course. If the employee has not been brought into compliance, they shall be removed from the project until such time as they have completed the required training.

Any costs associated with this notice shall be included in the general cost of the contract. In addition, there shall be no time granted to the contractor for compliance with this notice. The contractor's compliance with this notice and any associated regulations shall not be grounds for claims as outlined in Section 1.11 – "Claims".

(d) Awarding of Contracts to Occupational Safety and Health Law Violators Prohibited. The Contract is subject to Section 31-57b of the Connecticut General Statutes, as revised.

(e) Residents Preference in Work on Other Public Facilities. NOT APPLICABLE TO FEDERAL AID CONTRACTS. Pursuant to Section 31-52a of the Connecticut General Statutes, as revised, in the employment of mechanics, laborers or workmen to perform the work specified herein, preference shall be given to residents of the state who are, and continuously for at least six months prior to the date hereof have been, residents of this state, and if no such person is available, then to residents of other states

8. Tax Liability - Contractor's Exempt Purchase Certificate (CERT – 141)

The Contractor shall comply with Chapter 219 of the Connecticut General Statutes pertaining to tangible personal property or services rendered that is/are subject to sales tax. The Contractor is responsible for determining its tax liability. If the Contractor purchases materials or supplies pursuant to the Connecticut Department of Revenue Services' "Contractor's Exempt Purchase Certificate (CERT-141)," as may be revised, the Contractor acknowledges and agrees that title to such materials and supplies installed or placed in the project will vest in the State simultaneously with passage of title from the retailers or vendors thereof, and the Contractor will have no property rights in the materials and supplies purchased.

Forms and instructions are available anytime by:

Internet: Visit the DRS website at www.ct.gov/DRS to download and print Connecticut tax forms; or

Telephone: Call 1-800-382-9463 (Connecticut calls outside the Greater Hartford calling area only) and select Option 2 or call 860-297-4753 (from anywhere).

9. Executive Orders

This contract is subject to the provisions of Executive Order No. Three of Governor Thomas J. Meskill, promulgated June 16, 1971, concerning labor employment practices, Executive Order No. Seventeen of Governor Thomas J. Meskill, promulgated February 15, 1973, concerning the listing of employment openings and Executive Order No. Sixteen of Governor John G. Rowland promulgated August 4, 1999, concerning violence in the workplace, all of which are incorporated into and are made a part of the contract as if they had been fully set forth in it. The contract may also be subject to Executive Order No. 14 of Governor M. Jodi Rell, promulgated April 17, 2006, concerning procurement of cleaning products and services and to Executive Order No. 49 of Governor Dannel P. Malloy, promulgated May 22, 2015, mandating disclosure of certain gifts to public employees and contributions to certain candidates for office. If Executive Order No. 14 and/or Executive Order No. 49 are applicable, they are deemed to be incorporated into and are made a part of the contract as if they had been fully set forth in it. At the Contractor's request, the Department shall provide a copy of these orders to the Contractor.

10. Non Discrimination Requirement (pursuant to section 4a-60 and 4a-60a of the Connecticut General Statutes, as revised): References to "minority business enterprises" in this Section are not applicable to Federal-aid projects/contracts. Federal-aid projects/contracts are instead subject to the Federal Disadvantaged Business Enterprise Program.

(a) For purposes of this Section, the following terms are defined as follows:

- i. "Commission" means the Commission on Human Rights and Opportunities;
- ii. "Contract" and "contract" include any extension or modification of the Contract or contract;
- iii. "Contractor" and "contractor" include any successors or assigns of the Contractor or contractor;
- iv. "gender identity or expression" means a person's gender-related identity, appearance or behavior, whether or not that gender-related identity, appearance or behavior is different from that traditionally associated with the person's physiology or assigned sex at birth, which gender-related identity can be shown by providing evidence including, but not limited to, medical history, care or treatment of the gender-related identity, consistent and uniform assertion of the gender-related identity or any other evidence that the gender-related identity is sincerely held, part of a person's core identity or not being asserted for an improper purpose.
- v. "good faith" means that degree of diligence which a reasonable person would exercise in the performance of legal duties and obligations;
- vi. "good faith efforts" shall include, but not be limited to, those reasonable initial efforts necessary to comply with statutory or regulatory requirements and additional or substituted efforts when it is determined that such initial efforts will not be sufficient to comply with such requirements;
- vii. "marital status" means being single, married as recognized by the State of Connecticut, widowed, separated or divorced;
- viii. "mental disability" means one or more mental disorders, as defined in the most recent edition of the American Psychiatric Association's "Diagnostic and Statistical Manual of Mental Disorders", or a record of or regarding a person as having one or more such disorders;

- ix. "minority business enterprise" means any small contractor or supplier of materials fifty-one percent or more of the capital stock, if any, or assets of which is owned by a person or persons: (1) who are active in the daily affairs of the enterprise, (2) who have the power to direct the management and policies of the enterprise, and (3) who are members of a minority, as such term is defined in subsection (a) of Connecticut General Statutes § 32-9n; and
- x. "public works contract" means any agreement between any individual, firm or corporation and the State or any political subdivision of the State other than a municipality for construction, rehabilitation, conversion, extension, demolition or repair of a public building, highway or other changes or improvements in real property, or which is financed in whole or in part by the State, including, but not limited to, matching expenditures, grants, loans, insurance or guarantees.

For purposes of this Section, the terms "Contract" and "contract" do not include a contract where each contractor is (1) a political subdivision of the State, including, but not limited to, a municipality, (2) a quasi-public agency, as defined in Conn. Gen. Stat. Section 1-120, (3) any other state, including but not limited to any federally recognized Indian tribal governments, as defined in Conn. Gen. Stat. Section 1-267, (4) the federal government, (5) a foreign government, or (6) an agency of a subdivision, agency, state or government described in the immediately preceding enumerated items (1), (2), (3), (4) or (5).

- (b) (1) The Contractor agrees and warrants that in the performance of the Contract such Contractor will not discriminate or permit discrimination against any person or group of persons on the grounds of race, color, religious creed, age, marital status, national origin, ancestry, sex, gender identity or expression, intellectual disability, mental disability or physical disability, including, but not limited to, blindness, unless it is shown by such Contractor that such disability prevents performance of the work involved, in any manner prohibited by the laws of the United States or of the State of Connecticut; and the Contractor further agrees to take affirmative action to insure that applicants with job-related qualifications are employed and that employees are treated when employed without regard to their race, color, religious creed, age, marital status, national origin, ancestry, sex, gender identity or expression, intellectual disability, mental disability or physical disability, including, but not limited to, blindness, unless it is shown by the Contractor that such disability prevents performance of the work involved; (2) the Contractor agrees, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, to state that it is an "affirmative action-equal opportunity employer" in accordance with regulations adopted by the Commission; (3) the Contractor agrees to provide each labor union or representative of workers with which the Contractor has a collective bargaining Agreement or other contract or understanding and each vendor with which the Contractor has a contract or understanding, a notice to be provided by the Commission, advising the labor union or workers' representative of the Contractor's commitments under this section and to post copies of the notice in conspicuous places available to employees and applicants for employment; (4) the Contractor agrees to comply with each provision of this Section and Connecticut General Statutes §§ 46a-68e and 46a-68f and with each regulation or relevant order issued by said Commission pursuant to Connecticut General Statutes §§ 46a-56, 46a-68e and 46a-68f; and (5) the Contractor agrees to provide the Commission on Human Rights and Opportunities with such information requested by the Commission, and permit access to pertinent books, records and accounts, concerning the employment practices and procedures of the Contractor as relate to the provisions of this Section and Connecticut General Statutes § 46a-56. If the contract is a public works contract, the Contractor agrees and warrants that he will make good faith efforts to employ minority business enterprises as subcontractors and suppliers of materials on such public works projects.

- (c) Determination of the Contractor's good faith efforts shall include, but shall not be limited to, the following factors: The Contractor's employment and subcontracting policies, patterns and practices; affirmative advertising, recruitment and training; technical assistance activities and such other reasonable activities or efforts as the Commission may prescribe that are designed to ensure the participation of minority business enterprises in public works projects.
- (d) The Contractor shall develop and maintain adequate documentation, in a manner prescribed by the Commission, of its good faith efforts.
- (e) The Contractor shall include the provisions of subsection (b) of this Section in every subcontract or purchase order entered into in order to fulfill any obligation of a contract with the State and such provisions shall be binding on a subcontractor, vendor or manufacturer unless exempted by regulations or orders of the Commission. The Contractor shall take such action with respect to any such subcontract or purchase order as the Commission may direct as a means of enforcing such provisions including sanctions for noncompliance in accordance with Connecticut General Statutes §46a-56; provided if such Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the Commission, the Contractor may request the State of Connecticut to enter into any such litigation or negotiation prior thereto to protect the interests of the State and the State may so enter.
- (f) The Contractor agrees to comply with the regulations referred to in this Section as they exist on the date of this Contract and as they may be adopted or amended from time to time during the term of this Contract and any amendments thereto.
- (g) (1) The Contractor agrees and warrants that in the performance of the Contract such Contractor will not discriminate or permit discrimination against any person or group of persons on the grounds of sexual orientation, in any manner prohibited by the laws of the United States or the State of Connecticut, and that employees are treated when employed without regard to their sexual orientation; (2) the Contractor agrees to provide each labor union or representative of workers with which such Contractor has a collective bargaining Agreement or other contract or understanding and each vendor with which such Contractor has a contract or understanding, a notice to be provided by the Commission on Human Rights and Opportunities advising the labor union or workers' representative of the Contractor's commitments under this section, and to post copies of the notice in conspicuous places available to employees and applicants for employment; (3) the Contractor agrees to comply with each provision of this section and with each regulation or relevant order issued by said Commission pursuant to Connecticut General Statutes § 46a-56; and (4) the Contractor agrees to provide the Commission on Human Rights and Opportunities with such information requested by the Commission, and permit access to pertinent books, records and accounts, concerning the employment practices and procedures of the Contractor which relate to the provisions of this Section and Connecticut General Statutes § 46a-56.
- (h) The Contractor shall include the provisions of the foregoing paragraph in every subcontract or purchase order entered into in order to fulfill any obligation of a contract with the State and such provisions shall be binding on a subcontractor, vendor or manufacturer unless exempted by regulations or orders of the Commission. The Contractor shall take such action with respect to any such subcontract or purchase order as the Commission may direct as a means of enforcing such provisions including sanctions for noncompliance in accordance with Connecticut General Statutes § 46a-56; provided, if such Contractor becomes involved in, or is threatened with,

litigation with a subcontractor or vendor as a result of such direction by the Commission, the Contractor may request the State of Connecticut to enter into any such litigation or negotiation prior thereto to protect the interests of the State and the State may so enter.”

The Nondiscrimination Certifications can be found at the Office of Policy and Management website.

<http://www.ct.gov/opm/cwp/view.asp?a=2982&Q=390928>

11. Whistleblower Provision

The following clause is applicable if the Contract has a value of Five Million Dollars (\$5,000,000) or more.

Whistleblowing. This Contract may be subject to the provisions of Section 4-61dd of the Connecticut General Statutes. In accordance with this statute, if an officer, employee or appointing authority of the Contractor takes or threatens to take any personnel action against any employee of the Contractor in retaliation for such employee's disclosure of information to any employee of the contracting state or quasi-public agency or the Auditors of Public Accounts or the Attorney General under the provisions of subsection (a) of such statute, the Contractor shall be liable for a civil penalty of not more than five thousand dollars for each offense, up to a maximum of twenty per cent of the value of this Contract. Each violation shall be a separate and distinct offense and in the case of a continuing violation, each calendar day's continuance of the violation shall be deemed to be a separate and distinct offense. The State may request that the Attorney General bring a civil action in the Superior Court for the Judicial District of Hartford to seek imposition and recovery of such civil penalty. In accordance with subsection (f) of such statute, each large state contractor, as defined in the statute, shall post a notice of the provisions of the statute relating to large state contractors in a conspicuous place which is readily available for viewing by the employees of the Contractor.

12. Connecticut Freedom of Information Act

- (a) **Disclosure of Records.** This Contract may be subject to the provisions of section 1-218 of the Connecticut General Statutes. In accordance with this statute, each contract in excess of two million five hundred thousand dollars between a public agency and a person for the performance of a governmental function shall (a) provide that the public agency is entitled to receive a copy of records and files related to the performance of the governmental function, and (b) indicate that such records and files are subject to FOIA and may be disclosed by the public agency pursuant to FOIA. No request to inspect or copy such records or files shall be valid unless the request is made to the public agency in accordance with FOIA. Any complaint by a person who is denied the right to inspect or copy such records or files shall be brought to the Freedom of Information Commission in accordance with the provisions of sections 1-205 and 1-206 of the Connecticut General Statutes.
- (b) **Confidential Information.** The State will afford due regard to the Contractor's request for the protection of proprietary or confidential information which the State receives from the Contractor. However, all materials associated with the Contract are subject to the terms of the FOIA and all corresponding rules, regulations and interpretations. In making such a request, the Contractor may not merely state generally that the materials are proprietary or confidential in nature and not, therefore, subject to release to third parties. Those particular sentences, paragraphs, pages or sections that the Contractor believes are exempt from disclosure under the FOIA must be specifically identified as such. Convincing explanation and rationale sufficient to justify each exemption consistent with the FOIA must accompany the request. The rationale and explanation must be stated in terms of the prospective harm to the competitive position of the Contractor that would result if the identified material were to be released and the reasons why the materials are legally exempt

from release pursuant to the FOIA. To the extent that any other provision or part of the Contract conflicts or is in any way inconsistent with this section, this section controls and shall apply and the conflicting provision or part shall not be given effect. If the Contractor indicates that certain documentation is submitted in confidence, by specifically and clearly marking the documentation as "CONFIDENTIAL," DOT will first review the Contractor's claim for consistency with the FOIA (that is, review that the documentation is actually a trade secret or commercial or financial information and not required by statute), and if determined to be consistent, will endeavor to keep such information confidential to the extent permitted by law. See, *e.g.*, Conn. Gen. Stat. §1-210(b)(5)(A-B). The State, however, has no obligation to initiate, prosecute or defend any legal proceeding or to seek a protective order or other similar relief to prevent disclosure of any information that is sought pursuant to a FOIA request. Should the State withhold such documentation from a Freedom of Information requester and a complaint be brought to the Freedom of Information Commission, the Contractor shall have the burden of cooperating with DOT in defense of that action and in terms of establishing the availability of any FOIA exemption in any proceeding where it is an issue. In no event shall the State have any liability for the disclosure of any documents or information in its possession which the State believes are required to be disclosed pursuant to the FOIA or other law.

13. Service of Process

The Contractor, if not a resident of the State of Connecticut, or, in the case of a partnership, the partners, if not residents, hereby appoints the Secretary of State of the State of Connecticut, and his successors in office, as agent for service of process for any action arising out of or as a result of this Contract; such appointment to be in effect throughout the life of this Contract and six (6) years thereafter.

14. Substitution of Securities for Retainages on State Contracts and Subcontracts

This Contract is subject to the provisions of Section 3-112a of the General Statutes of the State of Connecticut, as revised.

15. Health Insurance Portability and Accountability Act of 1996 (HIPAA)

The Contractor shall comply, if applicable, with the Health Insurance Portability and Accountability Act of 1996 and, pursuant thereto, the provisions attached at Exhibit D, and hereby made part of this Contract.

16. Forum and Choice of Law

Forum and Choice of Law. The parties deem the Contract to have been made in the City of Hartford, State of Connecticut. Both parties agree that it is fair and reasonable for the validity and construction of the Contract to be, and it shall be, governed by the laws and court decisions of the State of Connecticut, without giving effect to its principles of conflicts of laws. To the extent that any immunities provided by Federal law or the laws of the State of Connecticut do not bar an action against the State, and to the extent that these courts are courts of competent jurisdiction, for the purpose of venue, the complaint shall be made returnable to the Judicial District of Hartford only or shall be brought in the United States District Court for the District of Connecticut only, and shall not be transferred to any other court, provided, however, that nothing here constitutes a waiver or compromise of the sovereign immunity of the State of Connecticut. The Contractor waives any objection which it may now have or will have to the laying of venue of any Claims in any forum and further irrevocably submits to such jurisdiction in any suit, action or proceeding.

17. Summary of State Ethics Laws

Pursuant to the requirements of section 1-101qq of the Connecticut General Statutes, the summary of State ethics laws developed by the State Ethics Commission pursuant to section 1-81b of the Connecticut General Statutes is incorporated by reference into and made a part of the Contract as if the summary had been fully set forth in the Contract.

18. Audit and Inspection of Plants, Places of Business and Records

- (a) The State and its agents, including, but not limited to, the Connecticut Auditors of Public Accounts, Attorney General and State's Attorney and their respective agents, may, at reasonable hours, inspect and examine all of the parts of the Contractor's and Contractor Parties' plants and places of business which, in any way, are related to, or involved in, the performance of this Contract. For the purposes of this Section, "Contractor Parties" means the Contractor's members, directors, officers, shareholders, partners, managers, principal officers, representatives, agents, servants, consultants, employees or any one of them or any other person or entity with whom the Contractor is in privity of oral or written contract and the Contractor intends for such other person or entity to Perform under the Contract in any capacity.
- (b) The Contractor shall maintain, and shall require each of the Contractor Parties to maintain, accurate and complete Records. The Contractor shall make all of its and the Contractor Parties' Records available at all reasonable hours for audit and inspection by the State and its agents.
- (c) The State shall make all requests for any audit or inspection in writing and shall provide the Contractor with at least twenty-four (24) hours' notice prior to the requested audit and inspection date. If the State suspects fraud or other abuse, or in the event of an emergency, the State is not obligated to provide any prior notice.
- (d) The Contractor shall keep and preserve or cause to be kept and preserved all of its and Contractor Parties' Records until three (3) years after the latter of (i) final payment under this Agreement, or (ii) the expiration or earlier termination of this Agreement, as the same may be modified for any reason. The State may request an audit or inspection at any time during this period. If any Claim or audit is started before the expiration of this period, the Contractor shall retain or cause to be retained all Records until all Claims or audit findings have been resolved.
- (e) The Contractor shall cooperate fully with the State and its agents in connection with an audit or inspection. Following any audit or inspection, the State may conduct and the Contractor shall cooperate with an exit conference.
- (f) The Contractor shall incorporate this entire Section verbatim into any contract or other agreement that it enters into with any Contractor Party.

19. Campaign Contribution Restriction

For all State contracts, defined in Conn. Gen. Stat. §9-612(f)(1) as having a value in a calendar year of \$50,000 or more, or a combination or series of such agreements or contracts having a value of \$100,000 or more, the authorized signatory to this contract expressly acknowledges receipt of the State Elections Enforcement Commission's notice advising state contractors of state campaign contribution and solicitation prohibitions, and will inform its principals of the contents of the notice, as set forth in "Notice to Executive Branch State Contractors and Prospective State Contractors of Campaign Contribution and Solicitation Limitations," a copy of which is attached hereto and hereby made a part of this contract, attached as Exhibit E.

20. Tangible Personal Property

- (a) The Contractor on its behalf and on behalf of its Affiliates, as defined below, shall comply with the provisions of Conn. Gen. Stat. §12-411b, as follows:

- (1) For the term of the Contract, the Contractor and its Affiliates shall collect and remit to the State of Connecticut, Department of Revenue Services, any Connecticut use tax due under the provisions of Chapter 219 of the Connecticut General Statutes for items of tangible personal property sold by the Contractor or by any of its Affiliates in the same manner as if the Contractor and such Affiliates were engaged in the business of selling tangible personal property for use in Connecticut and had sufficient nexus under the provisions of Chapter 219 to be required to collect Connecticut use tax;
 - (2) A customer's payment of a use tax to the Contractor or its Affiliates relieves the customer of liability for the use tax;
 - (3) The Contractor and its Affiliates shall remit all use taxes they collect from customers on or before the due date specified in the Contract, which may not be later than the last day of the month next succeeding the end of a calendar quarter or other tax collection period during which the tax was collected;
 - (4) The Contractor and its Affiliates are not liable for use tax billed by them but not paid to them by a customer; and
 - (5) Any Contractor or Affiliate who fails to remit use taxes collected on behalf of its customers by the due date specified in the Contract shall be subject to the interest and penalties provided for persons required to collect sales tax under chapter 219 of the general statutes.
- (b) For purposes of this section of the Contract, the word "Affiliate" means any person, as defined in section 12-1 of the general statutes, that controls, is controlled by, or is under common control with another person. A person controls another person if the person owns, directly or indirectly, more than ten per cent of the voting securities of the other person. The word "voting security" means a security that confers upon the holder the right to vote for the election of members of the board of directors or similar governing body of the business, or that is convertible into, or entitles the holder to receive, upon its exercise, a security that confers such a right to vote. "Voting security" includes a general partnership interest.
- (c) The Contractor represents and warrants that each of its Affiliates has vested in the Contractor plenary authority to so bind the Affiliates in any agreement with the State of Connecticut. The Contractor on its own behalf and on behalf of its Affiliates shall also provide, no later than 30 days after receiving a request by the State's contracting authority, such information as the State may require to ensure, in the State's sole determination, compliance with the provisions of Chapter 219 of the Connecticut General Statutes, including, but not limited to, §12-411b.

21. Bid Rigging and/or Fraud – Notice to Contractor

The Connecticut Department of Transportation is cooperating with the U.S. Department of Transportation and the Justice Department in their investigation into highway construction contract bid rigging and/or fraud.

A toll-free "HOT LINE" telephone number 800-424-9071 has been established to receive information from contractors, subcontractors, manufacturers, suppliers or anyone with knowledge of bid rigging and/or fraud, either past or current. The "HOT LINE" telephone number will be available during normal working hours (8:00 am – 5:00 pm EST). Information will be treated confidentially and anonymity respected.

22. Consulting Agreement Affidavit

The Contractor shall comply with Connecticut General Statutes Section 4a-81(a) and 4a-81(b), as revised. Pursuant to Public Act 11-229, after the initial submission of the form, if there is a change in the information contained in the form, a contractor shall submit the updated form, as applicable, either (i) not later than thirty (30) days after the effective date of such change or (ii) prior to execution of any new contract, whichever is earlier.

The Affidavit/Form may be submitted in written format or electronic format through the Department of Administrative Services (DAS) website.

23. Cargo Preference Act Requirements (46 CFR 381.7(a)-(b)) – Use of United States Flag Vessels

The Contractor agrees to comply with the following:

(a) ***Agreement Clauses.***

- (1) Pursuant to Pub. L. 664 ([43 U.S.C. 1241\(b\)](#)) at least 50 percent of any equipment, materials or commodities procured, contracted for or otherwise obtained with funds granted, guaranteed, loaned, or advanced by the U.S. Government under this agreement, and which may be transported by ocean vessel, shall be transported on privately owned United States-flag commercial vessels, if available.
- (2) Within 20 days following the date of loading for shipments originating within the United States or within 30 working days following the date of loading for shipments originating outside the United States, a legible copy of a rated, ‘on-board’ commercial ocean bill-of-lading in English for each shipment of cargo described in paragraph (a)(1) of this section shall be furnished to both the Contracting Officer (through the prime contractor in the case of subcontractor bills-of-lading) and to the Division of National Cargo, Office of Market Development, Maritime Administration, Washington, DC 20590.

(b) ***Contractor and Subcontractor Clauses.*** The contractor agrees—

- (1) To utilize privately owned United States-flag commercial vessels to ship at least 50 percent of the gross tonnage (computed separately for dry bulk carriers, dry cargo liners, and tankers) involved, whenever shipping any equipment, material, or commodities pursuant to this contract, to the extent such vessels are available at fair and reasonable rates for United States-flag commercial vessels.
- (2) To furnish within 20 days following the date of loading for shipments originating within the United States or within 30 working days following the date of loading for shipments originating outside the United States, a legible copy of a rated, ‘on-board’ commercial ocean bill-of-lading in English for each shipment of cargo described in paragraph (b) (1) of this section to both the Contracting Officer (through the prime contractor in the case of subcontractor bills-of-lading) and to the Division of National Cargo, Office of Market Development, Maritime Administration, Washington, DC 20590.
- (3) To insert the substance of the provisions of this clause in all subcontracts issued pursuant to this contract.

EXHIBIT A

FHWA-1273 -- Revised May 1, 2012

REQUIRED CONTRACT PROVISIONS FEDERAL-AID CONSTRUCTION CONTRACTS

- I. General
- II. Nondiscrimination
- III. Nonsegregated Facilities
- IV. Davis-Bacon and Related Act Provisions
- V. Contract Work Hours and Safety Standards Act Provisions
- VI. Subletting or Assigning the Contract
- VII. Safety: Accident Prevention
- VIII. False Statements Concerning Highway Projects
- IX. Implementation of Clean Air Act and Federal Water Pollution Control Act
- X. Compliance with Governmentwide Suspension and Debarment Requirements
- XI. Certification Regarding Use of Contract Funds for Lobbying

ATTACHMENTS

A. Employment and Materials Preference for Appalachian Development Highway System or Appalachian Local Access Road Contracts (included in Appalachian contracts only)

I. GENERAL

1. Form FHWA-1273 must be physically incorporated in each construction contract funded under Title 23 (excluding emergency contracts solely intended for debris removal). The contractor (or subcontractor) must insert this form in each subcontract and further require its inclusion in all lower tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services).

The applicable requirements of Form FHWA-1273 are incorporated by reference for work done under any purchase order, rental agreement or agreement for other services. The prime contractor shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Form FHWA-1273 must be included in all Federal-aid design-build contracts, in all subcontracts and in lower tier subcontracts (excluding subcontracts for design services, purchase orders, rental agreements and other agreements for supplies or services). The design-builder shall be responsible for compliance by any subcontractor, lower-tier subcontractor or service provider.

Contracting agencies may reference Form FHWA-1273 in bid proposal or request for proposal documents, however, the Form FHWA-1273 must be physically incorporated (not referenced) in all contracts, subcontracts and lower-tier subcontracts (excluding purchase orders, rental agreements and other agreements for supplies or services related to a construction contract).

2. Subject to the applicability criteria noted in the following sections, these contract provisions shall apply to all work performed on the contract by the contractor's own organization and with the

assistance of workers under the contractor's immediate superintendence and to all work performed on the contract by piecework, station work, or by subcontract.

3. A breach of any of the stipulations contained in these Required Contract Provisions may be sufficient grounds for withholding of progress payments, withholding of final payment, termination of the contract, suspension / debarment or any other action determined to be appropriate by the contracting agency and FHWA.

4. Selection of Labor: During the performance of this contract, the contractor shall not use convict labor for any purpose within the limits of a construction project on a Federal-aid highway unless it is labor performed by convicts who are on parole, supervised release, or probation. The term Federal-aid highway does not include roadways functionally classified as local roads or rural minor collectors.

II. NONDISCRIMINATION

The provisions of this section related to 23 CFR Part 230 are applicable to all Federal-aid construction contracts and to all related construction subcontracts of \$10,000 or more. The provisions of 23 CFR Part 230 are not applicable to material supply, engineering, or architectural service contracts.

In addition, the contractor and all subcontractors must comply with the following policies: Executive Order 11246, 41 CFR 60, 29 CFR 1625-1627, Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The contractor and all subcontractors must comply with: the requirements of the Equal Opportunity Clause in 41 CFR 60-1.4(b) and, for all construction contracts exceeding \$10,000, the Standard Federal Equal Employment Opportunity Construction Contract Specifications in 41 CFR 60-4.3.

Note: The U.S. Department of Labor has exclusive authority to determine compliance with Executive Order 11246 and the policies of the Secretary of Labor including 41 CFR 60, and 29 CFR 1625-1627. The contracting agency and the FHWA have the authority and the responsibility to ensure compliance with Title 23 USC Section 140, the Rehabilitation Act of 1973, as amended (29 USC 794), and Title VI of the Civil Rights Act of 1964, as amended, and related regulations including 49 CFR Parts 21, 26 and 27; and 23 CFR Parts 200, 230, and 633.

The following provision is adopted from 23 CFR 230, Appendix A, with appropriate revisions to conform to the U.S. Department of Labor (US DOL) and FHWA requirements.

1. Equal Employment Opportunity: Equal employment opportunity (EEO) requirements not to discriminate and to take affirmative action to assure equal opportunity as set forth under laws, executive orders, rules, regulations (28 CFR 35, 29 CFR 1630, 29 CFR 1625-1627, 41 CFR 60 and 49 CFR 27) and orders of the Secretary of Labor as modified by the provisions prescribed herein, and imposed pursuant to 23 U.S.C. 140 shall constitute the EEO and specific affirmative action standards for the contractor's project activities under this contract. The provisions of the Americans with Disabilities Act of 1990 (42 U.S.C. 12101 et seq.) set forth under 28 CFR 35 and 29 CFR 1630 are incorporated by reference in this contract. In the execution of this contract, the contractor agrees to comply with the following minimum specific requirement activities of EEO:

a. The contractor will work with the contracting agency and the Federal Government to ensure that it has made every good faith effort to provide equal opportunity with respect to all of its terms and conditions of employment and in their review of activities under the contract.

b. The contractor will accept as its operating policy the following statement:

"It is the policy of this Company to assure that applicants are employed, and that employees are treated during employment, without regard to their race, religion, sex, color, national origin, age or disability. Such action shall include: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship, pre-apprenticeship, and/or on-the-job training."

2. EEO Officer: The contractor will designate and make known to the contracting officers an EEO Officer who will have the responsibility for and must be capable of effectively administering and promoting an active EEO program and who must be assigned adequate authority and responsibility to do so.

3. Dissemination of Policy: All members of the contractor's staff who are authorized to hire, supervise, promote, and discharge employees, or who recommend such action, or who are substantially involved in such action, will be made fully cognizant of, and will implement, the contractor's EEO policy and contractual responsibilities to provide EEO in each grade and classification of employment. To ensure that the above agreement will be met, the following actions will be taken as a minimum:

a. Periodic meetings of supervisory and personnel office employees will be conducted before the start of work and then not less often than once every six months, at which time the contractor's EEO policy and its implementation will be reviewed and explained. The meetings will be conducted by the EEO Officer.

b. All new supervisory or personnel office employees will be given a thorough indoctrination by the EEO Officer, covering all major aspects of the contractor's EEO obligations within thirty days following their reporting for duty with the contractor.

c. All personnel who are engaged in direct recruitment for the project will be instructed by the EEO Officer in the contractor's procedures for locating and hiring minorities and women.

d. Notices and posters setting forth the contractor's EEO policy will be placed in areas readily accessible to employees, applicants for employment and potential employees.

e. The contractor's EEO policy and the procedures to implement such policy will be brought to the attention of employees by means of meetings, employee handbooks, or other appropriate means.

4. Recruitment: When advertising for employees, the contractor will include in all advertisements for employees the notation: "An Equal Opportunity Employer." All such advertisements will be placed in publications having a large circulation among minorities and women in the area from which the project work force would normally be derived.

a. The contractor will, unless precluded by a valid bargaining agreement, conduct systematic and direct recruitment through public and private employee referral sources likely to yield qualified minorities and women. To meet this requirement, the contractor will identify sources of potential

minority group employees, and establish with such identified sources procedures whereby minority and women applicants may be referred to the contractor for employment consideration.

b. In the event the contractor has a valid bargaining agreement providing for exclusive hiring hall referrals, the contractor is expected to observe the provisions of that agreement to the extent that the system meets the contractor's compliance with EEO contract provisions. Where implementation of such an agreement has the effect of discriminating against minorities or women, or obligates the contractor to do the same, such implementation violates Federal nondiscrimination provisions.

c. The contractor will encourage its present employees to refer minorities and women as applicants for employment. Information and procedures with regard to referring such applicants will be discussed with employees.

5. Personnel Actions: Wages, working conditions, and employee benefits shall be established and administered, and personnel actions of every type, including hiring, upgrading, promotion, transfer, demotion, layoff, and termination, shall be taken without regard to race, color, religion, sex, national origin, age or disability. The following procedures shall be followed:

a. The contractor will conduct periodic inspections of project sites to insure that working conditions and employee facilities do not indicate discriminatory treatment of project site personnel.

b. The contractor will periodically evaluate the spread of wages paid within each classification to determine any evidence of discriminatory wage practices.

c. The contractor will periodically review selected personnel actions in depth to determine whether there is evidence of discrimination. Where evidence is found, the contractor will promptly take corrective action. If the review indicates that the discrimination may extend beyond the actions reviewed, such corrective action shall include all affected persons.

d. The contractor will promptly investigate all complaints of alleged discrimination made to the contractor in connection with its obligations under this contract, will attempt to resolve such complaints, and will take appropriate corrective action within a reasonable time. If the investigation indicates that the discrimination may affect persons other than the complainant, such corrective action shall include such other persons. Upon completion of each investigation, the contractor will inform every complainant of all of their avenues of appeal.

6. Training and Promotion:

a. The contractor will assist in locating, qualifying, and increasing the skills of minorities and women who are applicants for employment or current employees. Such efforts should be aimed at developing full journey level status employees in the type of trade or job classification involved.

b. Consistent with the contractor's work force requirements and as permissible under Federal and State regulations, the contractor shall make full use of training programs, i.e., apprenticeship, and on-the-job training programs for the geographical area of contract performance. In the event a special provision for training is provided under this contract, this subparagraph will be superseded as indicated in the special provision. The contracting agency may reserve training positions for persons who receive welfare assistance in accordance with 23 U.S.C. 140(a).

c. The contractor will advise employees and applicants for employment of available training programs and entrance requirements for each.

d. The contractor will periodically review the training and promotion potential of employees who are minorities and women and will encourage eligible employees to apply for such training and promotion.

7. Unions: If the contractor relies in whole or in part upon unions as a source of employees, the contractor will use good faith efforts to obtain the cooperation of such unions to increase opportunities for minorities and women. Actions by the contractor, either directly or through a contractor's association acting as agent, will include the procedures set forth below:

a. The contractor will use good faith efforts to develop, in cooperation with the unions, joint training programs aimed toward qualifying more minorities and women for membership in the unions and increasing the skills of minorities and women so that they may qualify for higher paying employment.

b. The contractor will use good faith efforts to incorporate an EEO clause into each union agreement to the end that such union will be contractually bound to refer applicants without regard to their race, color, religion, sex, national origin, age or disability.

c. The contractor is to obtain information as to the referral practices and policies of the labor union except that to the extent such information is within the exclusive possession of the labor union and such labor union refuses to furnish such information to the contractor, the contractor shall so certify to the contracting agency and shall set forth what efforts have been made to obtain such information.

d. In the event the union is unable to provide the contractor with a reasonable flow of referrals within the time limit set forth in the collective bargaining agreement, the contractor will, through independent recruitment efforts, fill the employment vacancies without regard to race, color, religion, sex, national origin, age or disability; making full efforts to obtain qualified and/or qualifiable minorities and women. The failure of a union to provide sufficient referrals (even though it is obligated to provide exclusive referrals under the terms of a collective bargaining agreement) does not relieve the contractor from the requirements of this paragraph. In the event the union referral practice prevents the contractor from meeting the obligations pursuant to Executive Order 11246, as amended, and these special provisions, such contractor shall immediately notify the contracting agency.

8. Reasonable Accommodation for Applicants / Employees with Disabilities: The contractor must be familiar with the requirements for and comply with the Americans with Disabilities Act and all rules and regulations established there under. Employers must provide reasonable accommodation in all employment activities unless to do so would cause an undue hardship.

9. Selection of Subcontractors, Procurement of Materials and Leasing of Equipment: The contractor shall not discriminate on the grounds of race, color, religion, sex, national origin, age or disability in the selection and retention of subcontractors, including procurement of materials and leases of equipment. The contractor shall take all necessary and reasonable steps to ensure nondiscrimination in the administration of this contract.

a. The contractor shall notify all potential subcontractors and suppliers and lessors of their EEO obligations under this contract.

b. The contractor will use good faith efforts to ensure subcontractor compliance with their EEO obligations.

10. Assurance Required by 49 CFR 26.13(b):

a. The requirements of 49 CFR Part 26, and the State DOT's U.S. DOT-approved DBE program are incorporated by reference.

b. The contractor or subcontractor shall not discriminate on the basis of race, color, national origin, or sex in the performance of this contract. The contractor shall carry out applicable requirements of 49 CFR Part 26, in the award and administration of DOT-assisted contracts. Failure by the contractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the contracting agency deems appropriate.

11. Records and Reports: The contractor shall keep such records as necessary to document compliance with the EEO requirements. Such records shall be retained for a period of three years following the date of the final payment to the contractor for all contract work and shall be available at reasonable times and places for inspection by authorized representatives of the contracting agency and the FHWA.

a. The records kept by the contractor shall document the following:

(1) The number and work hours of minority and non-minority group members and women employed in each work classification on the project;

(2) The progress and efforts being made in cooperation with unions, when applicable, to increase employment opportunities for minorities and women; and

(3) The progress and efforts being made in locating, hiring, training, qualifying, and upgrading minorities and women;

b. The contractors and subcontractors will submit an annual report to the contracting agency each July for the duration of the project, indicating the number of minority, women, and non-minority group employees currently engaged in each work classification required by the contract work. This information is to be reported on [Form FHWA-1391](#). The staffing data should represent the project work force on board in all or any part of the last payroll period preceding the end of July. If on-the-job training is being required by special provision, the contractor will be required to collect and report training data. The employment data should reflect the work force on board during all or any part of the last payroll period preceding the end of July.

III. NONSEGREGATED FACILITIES

This provision is applicable to all Federal-aid construction contracts and to all related construction subcontracts of \$10,000 or more.

The contractor must ensure that facilities provided for employees are provided in such a manner that segregation on the basis of race, color, religion, sex, or national origin cannot result. The contractor may neither require such segregated use by written or oral policies nor tolerate such use by employee custom. The contractor's obligation extends further to ensure that its employees are not assigned to perform their services at any location, under the contractor's control, where the facilities are segregated. The term "facilities" includes waiting rooms, work areas, restaurants and other eating

areas, time clocks, restrooms, washrooms, locker rooms, and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing provided for employees. The contractor shall provide separate or single-user restrooms and necessary dressing or sleeping areas to assure privacy between sexes.

IV. DAVIS-BACON AND RELATED ACT PROVISIONS

This section is applicable to all Federal-aid construction projects exceeding \$2,000 and to all related subcontracts and lower-tier subcontracts (regardless of subcontract size). The requirements apply to all projects located within the right-of-way of a roadway that is functionally classified as Federal-aid highway. This excludes roadways functionally classified as local roads or rural minor collectors, which are exempt. Contracting agencies may elect to apply these requirements to other projects.

The following provisions are from the U.S. Department of Labor regulations in 29 CFR 5.5 “Contract provisions and related matters” with minor revisions to conform to the FHWA-1273 format and FHWA program requirements.

1. Minimum wages

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

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

b. (1) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

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

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

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

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

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

(4) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs 1.b.(2) or 1.b.(3) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

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

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

2. Withholding

The contracting agency shall upon its own action or upon written request of an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract, or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or

any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the contracting agency may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

3. Payrolls and basic records

a. Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

b. (1) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the contracting agency. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g. , the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at <http://www.dol.gov/esa/whd/forms/wh347instr.htm> or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the contracting agency for transmission to the State DOT, the FHWA or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the contracting agency..

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

- (i) That the payroll for the payroll period contains the information required to be provided under §5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under §5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(ii) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

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

(3) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph 3.b.(2) of this section.

(4) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

c. The contractor or subcontractor shall make the records required under paragraph 3.a. of this section available for inspection, copying, or transcription by authorized representatives of the contracting agency, the State DOT, the FHWA, or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the FHWA may, after written notice to the contractor, the contracting agency or the State DOT, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

4. Apprentices and trainees

a. Apprentices (programs of the USDOL).

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

The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is

registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed.

Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination.

In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

b. Trainees (programs of the USDOL).

Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration.

The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration.

Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed.

In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

c. Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

d. Apprentices and Trainees (programs of the U.S. DOT).

Apprentices and trainees working under apprenticeship and skill training programs which have been certified by the Secretary of Transportation as promoting EEO in connection with Federal-aid highway construction programs are not subject to the requirements of paragraph 4 of this Section IV. The straight time hourly wage rates for apprentices and trainees under such programs will be established by the particular programs. The ratio of apprentices and trainees to journeymen shall not be greater than permitted by the terms of the particular program.

5. Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

6. Subcontracts. The contractor or subcontractor shall insert Form FHWA-1273 in any subcontracts and also require the subcontractors to include Form FHWA-1273 in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

7. Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

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

10. Certification of eligibility.

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

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

c. The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

V. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

The following clauses apply to any Federal-aid construction contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by 29 CFR 5.5(a) or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

1. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit

any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

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

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

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

VI. SUBLETTING OR ASSIGNING THE CONTRACT

This provision is applicable to all Federal-aid construction contracts on the National Highway System.

1. The contractor shall perform with its own organization contract work amounting to not less than 30 percent (or a greater percentage if specified elsewhere in the contract) of the total original contract price, excluding any specialty items designated by the contracting agency. Specialty items may be performed by subcontract and the amount of any such specialty items performed may be deducted from the total original contract price before computing the amount of work required to be performed by the contractor's own organization (23 CFR 635.116).

a. The term “perform work with its own organization” refers to workers employed or leased by the prime contractor, and equipment owned or rented by the prime contractor, with or without operators. Such term does not include employees or equipment of a subcontractor or lower tier subcontractor, agents of the prime contractor, or any other assignees. The term may include payments for the costs of hiring leased employees from an employee leasing firm meeting all relevant Federal and State regulatory requirements. Leased employees may only be included in this term if the prime contractor meets all of the following conditions:

- (1) the prime contractor maintains control over the supervision of the day-to-day activities of the leased employees;
- (2) the prime contractor remains responsible for the quality of the work of the leased employees;
- (3) the prime contractor retains all power to accept or exclude individual employees from work on the project; and
- (4) the prime contractor remains ultimately responsible for the payment of predetermined minimum wages, the submission of payrolls, statements of compliance and all other Federal regulatory requirements.

b. "Specialty Items" shall be construed to be limited to work that requires highly specialized knowledge, abilities, or equipment not ordinarily available in the type of contracting organizations qualified and expected to bid or propose on the contract as a whole and in general are to be limited to minor components of the overall contract.

2. The contract amount upon which the requirements set forth in paragraph (1) of Section VI is computed includes the cost of material and manufactured products which are to be purchased or produced by the contractor under the contract provisions.

3. The contractor shall furnish (a) a competent superintendent or supervisor who is employed by the firm, has full authority to direct performance of the work in accordance with the contract requirements, and is in charge of all construction operations (regardless of who performs the work) and (b) such other of its own organizational resources (supervision, management, and engineering services) as the contracting officer determines is necessary to assure the performance of the contract.

4. No portion of the contract shall be sublet, assigned or otherwise disposed of except with the written consent of the contracting officer, or authorized representative, and such consent when given shall not be construed to relieve the contractor of any responsibility for the fulfillment of the contract. Written consent will be given only after the contracting agency has assured that each subcontract is evidenced in writing and that it contains all pertinent provisions and requirements of the prime contract.

5. The 30% self-performance requirement of paragraph (1) is not applicable to design-build contracts; however, contracting agencies may establish their own self-performance requirements.

VII. SAFETY: ACCIDENT PREVENTION

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

1. In the performance of this contract the contractor shall comply with all applicable Federal, State, and local laws governing safety, health, and sanitation (23 CFR 635). The contractor shall provide all safeguards, safety devices and protective equipment and take any other needed actions as it determines, or as the contracting officer may determine, to be reasonably necessary to protect the life and health of employees on the job and the safety of the public and to protect property in connection with the performance of the work covered by the contract.

2. It is a condition of this contract, and shall be made a condition of each subcontract, which the contractor enters into pursuant to this contract, that the contractor and any subcontractor shall not permit any employee, in performance of the contract, to work in surroundings or under conditions which are unsanitary, hazardous or dangerous to his/her health or safety, as determined under

construction safety and health standards (29 CFR 1926) promulgated by the Secretary of Labor, in accordance with Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3704).

3. Pursuant to 29 CFR 1926.3, it is a condition of this contract that the Secretary of Labor or authorized representative thereof, shall have right of entry to any site of contract performance to inspect or investigate the matter of compliance with the construction safety and health standards and to carry out the duties of the Secretary under Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C.3704).

VIII. FALSE STATEMENTS CONCERNING HIGHWAY PROJECTS

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

In order to assure high quality and durable construction in conformity with approved plans and specifications and a high degree of reliability on statements and representations made by engineers, contractors, suppliers, and workers on Federal-aid highway projects, it is essential that all persons concerned with the project perform their functions as carefully, thoroughly, and honestly as possible. Willful falsification, distortion, or misrepresentation with respect to any facts related to the project is a violation of Federal law. To prevent any misunderstanding regarding the seriousness of these and similar acts, Form FHWA-1022 shall be posted on each Federal-aid highway project (23 CFR 635) in one or more places where it is readily available to all persons concerned with the project:

18 U.S.C. 1020 reads as follows:

"Whoever, being an officer, agent, or employee of the United States, or of any State or Territory, or whoever, whether a person, association, firm, or corporation, knowingly makes any false statement, false representation, or false report as to the character, quality, quantity, or cost of the material used or to be used, or the quantity or quality of the work performed or to be performed, or the cost thereof in connection with the submission of plans, maps, specifications, contracts, or costs of construction on any highway or related project submitted for approval to the Secretary of Transportation; or

Whoever knowingly makes any false statement, false representation, false report or false claim with respect to the character, quality, quantity, or cost of any work performed or to be performed, or materials furnished or to be furnished, in connection with the construction of any highway or related project approved by the Secretary of Transportation; or

Whoever knowingly makes any false statement or false representation as to material fact in any statement, certificate, or report submitted pursuant to provisions of the Federal-aid Roads Act approved July 1, 1916, (39 Stat. 355), as amended and supplemented;

Shall be fined under this title or imprisoned not more than 5 years or both."

IX. IMPLEMENTATION OF CLEAN AIR ACT AND FEDERAL WATER POLLUTION CONTROL ACT

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts.

By submission of this bid/proposal or the execution of this contract, or subcontract, as appropriate, the bidder, proposer, Federal-aid construction contractor, or subcontractor, as appropriate, will be deemed to have stipulated as follows:

1. That any person who is or will be utilized in the performance of this contract is not prohibited from receiving an award due to a violation of Section 508 of the Clean Water Act or Section 306 of the Clean Air Act.
2. That the contractor agrees to include or cause to be included the requirements of paragraph (1) of this Section X in every subcontract, and further agrees to take such action as the contracting agency may direct as a means of enforcing such requirements.

X. CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION

This provision is applicable to all Federal-aid construction contracts, design-build contracts, subcontracts, lower-tier subcontracts, purchase orders, lease agreements, consultant contracts or any other covered transaction requiring FHWA approval or that is estimated to cost \$25,000 or more – as defined in 2 CFR Parts 180 and 1200.

1. Instructions for Certification – First Tier Participants:

- a. By signing and submitting this proposal, the prospective first tier participant is providing the certification set out below.
- b. The inability of a person to provide the certification set out below will not necessarily result in denial of participation in this covered transaction. The prospective first tier participant shall submit an explanation of why it cannot provide the certification set out below. The certification or explanation will be considered in connection with the department or agency's determination whether to enter into this transaction. However, failure of the prospective first tier participant to furnish a certification or an explanation shall disqualify such a person from participation in this transaction.
- c. The certification in this clause is a material representation of fact upon which reliance was placed when the contracting agency determined to enter into this transaction. If it is later determined that the prospective participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the contracting agency may terminate this transaction for cause of default.
- d. The prospective first tier participant shall provide immediate written notice to the contracting agency to whom this proposal is submitted if any time the prospective first tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.
- e. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. "First Tier Covered Transactions" refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). "Lower Tier Covered Transactions" refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). "First Tier Participant" refers to the participant who has entered into a covered

transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). “Lower Tier Participant” refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

f. The prospective first tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency entering into this transaction.

g. The prospective first tier participant further agrees by submitting this proposal that it will include the clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transactions," provided by the department or contracting agency, entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the \$25,000 threshold.

h. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (<https://www.epls.gov/>), which is compiled by the General Services Administration.

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

j. Except for transactions authorized under paragraph (f) of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency may terminate this transaction for cause or default.

* * * * *

2. Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – First Tier Participants:

a. The prospective first tier participant certifies to the best of its knowledge and belief, that it and its principals:

(1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency;

(2) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with

obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;

(3) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (a)(2) of this certification; and

(4) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.

b. Where the prospective participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

2. Instructions for Certification - Lower Tier Participants:

(Applicable to all subcontracts, purchase orders and other lower tier transactions requiring prior FHWA approval or estimated to cost \$25,000 or more - 2 CFR Parts 180 and 1200)

a. By signing and submitting this proposal, the prospective lower tier is providing the certification set out below.

b. The certification in this clause is a material representation of fact upon which reliance was placed when this transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the department, or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

c. The prospective lower tier participant shall provide immediate written notice to the person to which this proposal is submitted if at any time the prospective lower tier participant learns that its certification was erroneous by reason of changed circumstances.

d. The terms "covered transaction," "debarred," "suspended," "ineligible," "participant," "person," "principal," and "voluntarily excluded," as used in this clause, are defined in 2 CFR Parts 180 and 1200. You may contact the person to which this proposal is submitted for assistance in obtaining a copy of those regulations. "First Tier Covered Transactions" refers to any covered transaction between a grantee or subgrantee of Federal funds and a participant (such as the prime or general contract). "Lower Tier Covered Transactions" refers to any covered transaction under a First Tier Covered Transaction (such as subcontracts). "First Tier Participant" refers to the participant who has entered into a covered transaction with a grantee or subgrantee of Federal funds (such as the prime or general contractor). "Lower Tier Participant" refers any participant who has entered into a covered transaction with a First Tier Participant or other Lower Tier Participants (such as subcontractors and suppliers).

e. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized by the department or agency with which this transaction originated.

f. The prospective lower tier participant further agrees by submitting this proposal that it will include this clause titled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion-Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions exceeding the \$25,000 threshold.

g. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant is responsible for ensuring that its principals are not suspended, debarred, or otherwise ineligible to participate in covered transactions. To verify the eligibility of its principals, as well as the eligibility of any lower tier prospective participants, each participant may, but is not required to, check the Excluded Parties List System website (<https://www.epls.gov/>), which is compiled by the General Services Administration.

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

i. Except for transactions authorized under paragraph e of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to other remedies available to the Federal Government, the department or agency with which this transaction originated may pursue available remedies, including suspension and/or debarment.

* * * * *

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion--Lower Tier Participants:

1. The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participating in covered transactions by any Federal department or agency.

2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

* * * * *

XI. CERTIFICATION REGARDING USE OF CONTRACT FUNDS FOR LOBBYING

This provision is applicable to all Federal-aid construction contracts and to all related subcontracts which exceed \$100,000 (49 CFR 20).

1. The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

a. No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency,

a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

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

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

3. The prospective participant also agrees by submitting its bid or proposal that the participant shall require that the language of this certification be included in all lower tier subcontracts, which exceed \$100,000 and that all such recipients shall certify and disclose accordingly.

**ATTACHMENT A - EMPLOYMENT AND MATERIALS PREFERENCE FOR
APPALACHIAN DEVELOPMENT HIGHWAY SYSTEM OR APPALACHIAN LOCAL
ACCESS ROAD CONTRACTS**

This provision is applicable to all Federal-aid projects funded under the Appalachian Regional Development Act of 1965.

1. During the performance of this contract, the contractor undertaking to do work which is, or reasonably may be, done as on-site work, shall give preference to qualified persons who regularly reside in the labor area as designated by the DOL wherein the contract work is situated, or the subregion, or the Appalachian counties of the State wherein the contract work is situated, except:

a. To the extent that qualified persons regularly residing in the area are not available.

b. For the reasonable needs of the contractor to employ supervisory or specially experienced personnel necessary to assure an efficient execution of the contract work.

c. For the obligation of the contractor to offer employment to present or former employees as the result of a lawful collective bargaining contract, provided that the number of nonresident persons employed under this subparagraph (1c) shall not exceed 20 percent of the total number of employees employed by the contractor on the contract work, except as provided in subparagraph (4) below.

2. The contractor shall place a job order with the State Employment Service indicating (a) the classifications of the laborers, mechanics and other employees required to perform the contract work, (b) the number of employees required in each classification, (c) the date on which the participant estimates such employees will be required, and (d) any other pertinent information required by the State Employment Service to complete the job order form. The job order may be placed with the State Employment Service in writing or by telephone. If during the course of the contract work, the information submitted by the contractor in the original job order is substantially modified, the participant shall promptly notify the State Employment Service.

3. The contractor shall give full consideration to all qualified job applicants referred to him by the State Employment Service. The contractor is not required to grant employment to any job applicants who, in his opinion, are not qualified to perform the classification of work required.

4. If, within one week following the placing of a job order by the contractor with the State Employment Service, the State Employment Service is unable to refer any qualified job applicants to the contractor, or less than the number requested, the State Employment Service will forward a certificate to the contractor indicating the unavailability of applicants. Such certificate shall be made a part of the contractor's permanent project records. Upon receipt of this certificate, the contractor may employ persons who do not normally reside in the labor area to fill positions covered by the certificate, notwithstanding the provisions of subparagraph (1c) above.

5. The provisions of 23 CFR 633.207(e) allow the contracting agency to provide a contractual preference for the use of mineral resource materials native to the Appalachian region.

EXHIBIT B**TITLE VI CONTRACTOR ASSURANCES**

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

1. **Compliance with Regulations:** The Contractor shall comply with the regulations relative to nondiscrimination in federally assisted programs of the United States Department of Transportation (hereinafter, "USDOT"), Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time (hereinafter referred to as the "Regulations"), which are herein incorporated by reference and made a part of this contract.

2. **Nondiscrimination:** The Contractor, with regard to the work performed by it during the Contract, shall not discriminate on the grounds of race, color, national origin, sex, age, or disability in the selection and retention of subcontractors, including procurements of materials and leases of equipment. The Contractor shall not participate either directly or indirectly in the discrimination prohibited by Subsection 5 of the Regulations, including employment practices when the Contract covers a program set forth in Appendix B of the Regulations.

3. **Solicitations for Subcontracts, Including Procurements of Materials and Equipment:**

In all solicitations either by competitive bidding or negotiation made by the Contractor for work to be performed under a subcontract, including procurements of materials or leases of equipment, each potential subcontractor or supplier shall be notified by the Contractor of the Contractor's obligations under this contract and the Regulations relative to nondiscrimination on the grounds of race, color, national origin, sex, age, or disability.

4. **Information and Reports:** The Contractor shall provide all information and reports required by the Regulations or directives issued pursuant thereto and shall permit access to its books, records, accounts, other sources of information, and its facilities as may be determined by the Connecticut Department of Transportation (ConnDOT) or the Funding Agency (FHWA, FTA and FAA) to be pertinent to ascertain compliance with such Regulations, orders, and instructions. Where any information required of a Contractor is in the exclusive possession of another who fails or refuses to furnish this information, the Contractor shall so certify to ConnDOT or the Funding Agency, as appropriate, and shall set forth what efforts it has made to obtain the information.

5. **Sanctions for Noncompliance:** In the event of the Contractor's noncompliance with the nondiscrimination provisions of this Contract, the ConnDOT shall impose such sanctions as it or the Funding Agency may determine to be appropriate, including, but not limited to:

- A. Withholding contract payments until the Contractor is in-compliance; and/or
- B. Cancellation, termination, or suspension of the Contract, in whole or in part.

6. **Incorporation of Provisions:** The Contractor shall include the provisions of paragraphs 1 through 5 in every subcontract, including procurements of materials and leases of equipment, unless exempt by the Regulations or directives issued pursuant thereto. The Contractor shall take such action with respect to any subcontract or procurement as the ConnDOT or the Funding Agency may -direct as a means of enforcing such provisions including sanctions for noncompliance. Provided, however, that in the event a Contractor becomes involved in, or is threatened with, litigation with a subcontractor or supplier as a result of such direction, the Contractor may request the ConnDOT to enter into such litigation to protect the interests of the Funding Agency, and, in addition, the Contractor may request the United States to enter into such litigation to protect the interests of the United States

EXHIBIT C**CONTRACTOR WORKFORCE UTILIZATION (FEDERAL EXECUTIVE ORDER 11246) /
EQUAL EMPLOYMENT OPPORTUNITY
(Federal - FHWA)****1. Project Workforce Utilization Goals:**

These goals are applicable to all the Contractor's construction work (whether or not it is Federal or Federally assisted or funded) performed in the covered area. If the contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for the geographical area where the work is actually performed.

Whenever the Contractor, or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of \$10,000 the provisions of these specifications which contain the applicable goals for minority and female participation.

The goals for minority and female utilization are expressed in percentage terms for the contractor's aggregate work-force in each trade on all construction work in the covered area, are referenced in the attached Appendix A.

2. Executive Order 11246

The Contractor's compliance with Executive Order 11246 and 41-CFR Part 60-4 shall be based on its implementation of the specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(A) and its efforts to meet the goals established for the geographical area where the contract is to be performed. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from contractor to contractor or from project to project for the sole purpose of meeting the contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hour performed.

If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or subcontractors toward a goal in an approved Pan does not excuse any covered Contractor's or subcontractor's failure to take good faith efforts to achieve the plan goals and timetables.

The Contractor shall implement the specific affirmative action standards provided in a through p of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in

which it has employees in the covered area. Covered Construction contractors performing construction work in geographical areas where they do not have a federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form and such notices may be obtained from any Office of Federal Contract Compliance Programs (OFCCP) Office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.

Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant hereto.

In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

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

- a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites; and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.
- b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.
- c. Maintain a current file of the names, addresses and telephone numbers of each minority and female off the street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason thereafter; along with whatever additional actions the Contractor may have taken.
- d. Provide immediate written notification to the Director when the Union or Unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or women sent by the Contractor, or when the Contractor has other

information that the Union referral process has impeded the Contractor's efforts to meet its obligations.

- e. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under b above.
- f. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO Policy on bulletin boards accessible to all employees at each location where construction work is performed.
- g. Review, at least annually, the company EEO Policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment, decisions including specific Foreman, etc. prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.
- h. Disseminate the Contractor's EEO Policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and subcontractors with whom the Contractor does or anticipates doing business.
- i. Direct its recruitment efforts, both oral and written, to minority female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the contractor shall send written notification to organizations such as the above, describing the openings, screening procedures and tests to be used in the selection process.
- j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's work-force.
- k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.
- l. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.
- m. Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and

employment related activities to ensure that the EEO policy and the Contractor's obligations under these specifications are being carried out.

- n. Ensure that all facilities and company activities are non-segregated except that separate or single user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.
- o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.
- p. Conduct a review at least annually of all supervisors' adherence to and performance under the Contractor's EEO policies and affirmative action obligations.

Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations (a through p). The efforts of a contractor association, joint contractor union, contractor community, or other similar group of which the contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under a through p of these specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female work-force participation, makes a good faith effort to meet with individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.

A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of Executive Order 11246 if a particular group is employed in a substantially disparate manner, (for example, even though the Contractor has achieved its goals for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is under utilized).

The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.

The Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.

The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.

The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in these

specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status, (e.g. mechanic, apprentice, trainee, helper, or laborer) dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

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

The Director of the Office of Federal Contract Compliance Programs, from time to time, shall issue goals and timetables for minority and female utilization which shall be based on appropriate workforce, demographic or other relevant data and which shall cover construction projects or construction contracts performed in specific geographical areas. The goals, which shall be applicable to each construction trade in a covered contractor's or timetables, shall be published as notices in the Federal Register, and shall be inserted by the Contracting officers and applicants, as applicable, in the Notice required by 41 CFR 60-4.2.

FEDERALLY FUNDED OR ASSISTED PROJECTS**APPENDIX A****(Labor Market Goals)****Standard Metropolitan Statistical Area (SMSA)****Female****Minority**

Bridgeport – Stamford – Norwalk – Danbury	10.2%
6.9%	

Bethel	Bridgeport	Brookfield	Danbury
Darien	Derby	Easton	Fairfield
Greenwich	Milford	Monroe	New Canaan
New Fairfield	Newton	Norwalk	Redding
Shelton	Stamford	Stratford	Trumbull
Weston	Westport	Wilton	

Hartford – Bristol – New Britain	6.9%
6.9%	

Andover	Avon	Berlin	Bloomfield
Bolton	Bristol	Burlington	Canton
Colchester	Columbia	Coventry	Cromwell
East Granby	East Hampton	East Hartford	East Windsor
Ellington	Enfield	Farmington	Glastonbury
Granby	Hartford	Hebron	Manchester
Marlborough	New Britain	New Hartford	Newington
Plainville	Plymouth	Portland	Rocky Hill
Simsbury	South Windsor	Southington	Stafford
Suffield	Tolland	Vernon	West Hartford
Wethersfield	Willington	Windsor	Windsor Locks

New Haven – Waterbury – Meriden	9.0%
6.9%	

Beacon Falls	Bethany	Branford	Cheshire
Clinton	East Haven	Guilford	Hamden
Madison	Meriden	Middlebury	Naugatuck
New Haven	North Branford	North Haven	Orange
Prospect	Southbury	Thomaston	Wallingford
Waterbury	Watertown	West Haven	Wolcott
Woodbridge	Woodbury		

New London – Norwich	4.5%
6.9%	

Bozrah	East Lyme	Griswold	Groton
Ledyard	Lisbon	Montville	New London
Norwich	Old Lyme	Old Saybrook	Preston
Sprague	Stonington	Waterford	

Non SMSA**Female****Minority**

Litchfield – Windham			5.9%
6.9%			
Abington	Ashford	Ballouville	Bantam
Barkhamsted	Bethlehem	Bridgewater	Brooklyn
Canaan	Canterbury	Central Village	Cahplin
Colebrook	Cornwall	Cornwall Bridge	Danielson
Dayville	East Canaan	East Killingly	East Woodstock
Eastford	Falls Village	Gaylordsville	Goshen
Grosvenor Dale	Hampton	Harwinton	Kent
Killigly	Lakeside	Litchfield	Moosup
Morris	New Milford	New Preston	New Preston Marble Dale
Norfolk	North Canaan	No. Grosvenordale	North Windham
Oneco	Pequabuck	Pine Meadow	Plainfield
Pleasant Valley	Pomfret	Pomfret Center	Putnam
Quinebaug	Riverton	Rogers	Roxbury
Salisbury	Scotland	Sharon	South Kent
South Woodstock	Sterling	Taconic	Terryville
Thompson	Torrington	Warren	Warrenville
Washington	Washington Depot	Wauregan	West Cornwall
Willimantic	Winchester	Winchester Center	Windham
Winsted	Woodstock	Woodstock Valley	

EXHIBIT D**Health Insurance Portability and Accountability Act of 1996 (“HIPAA”).**

- (a) If the Contactor is a Business Associate under the requirements of the Health Insurance Portability and Accountability Act of 1996 (“HIPAA”), the Contractor must comply with all terms and conditions of this Section of the Contract. If the Contractor is not a Business Associate under HIPAA, this Section of the Contract does not apply to the Contractor for this Contract.
- (b) The Contractor is required to safeguard the use, publication and disclosure of information on all applicants for, and all clients who receive, services under the Contract in accordance with all applicable federal and state law regarding confidentiality, which includes but is not limited to HIPAA, more specifically with the Privacy and Security Rules at 45 C.F.R. Part 160 and Part 164, subparts A, C, and E; and
- (c) The State of Connecticut Agency named on page 1 of this Contract (hereinafter the “Department”) is a “covered entity” as that term is defined in 45 C.F.R. § 160.103; and
- (d) The Contractor, on behalf of the Department, performs functions that involve the use or disclosure of “individually identifiable health information,” as that term is defined in 45 C.F.R. § 160.103; and
- (e) The Contractor is a “business associate” of the Department, as that term is defined in 45 C.F.R. § 160.103; and
- (f) The Contractor and the Department agree to the following in order to secure compliance with the HIPAA, the requirements of Subtitle D of the Health Information Technology for Economic and Clinical Health Act (hereinafter the HITECH Act), (Pub. L. 111-5, sections 13400 to 13423), and more specifically with the Privacy and Security Rules at 45 C.F.R. Part 160 and Part 164, subparts A, C, and E.
- (g) Definitions
 - (1) “Breach shall have the same meaning as the term is defined in section 13400 of the HITECH Act (42 U.S.C. §17921(1))
 - (2) “Business Associate” shall mean the Contractor.
 - (3) “Covered Entity” shall mean the Department of the State of Connecticut named on page 1 of this Contract.
 - (4) “Designated Record Set” shall have the same meaning as the term “designated record set” in 45 C.F.R. § 164.501.
 - (5) “Electronic Health Record” shall have the same meaning as the term is defined in section 13400 of the HITECH Act (42 U.S.C. §17921(5))

- (6) "Individual" shall have the same meaning as the term "individual" in 45 C.F.R. § 160.103 and shall include a person who qualifies as a personal representative as defined in 45 C.F.R. § 164.502(g).
 - (7) "Privacy Rule" shall mean the Standards for Privacy of Individually Identifiable Health Information at 45 C.F.R. part 160 and parts 164, subparts A and E.
 - (8) "Protected Health Information" or "PHI" shall have the same meaning as the term "protected health information" in 45 C.F.R. § 160.103, limited to information created or received by the Business Associate from or on behalf of the Covered Entity.
 - (9) "Required by Law" shall have the same meaning as the term "required by law" in 45 C.F.R. § 164.103.
 - (10) "Secretary" shall mean the Secretary of the Department of Health and Human Services or his designee.
 - (11) "More stringent" shall have the same meaning as the term "more stringent" in 45 C.F.R. § 160.202.
 - (12) "This Section of the Contract" refers to the HIPAA Provisions stated herein, in their entirety.
 - (13) "Security Incident" shall have the same meaning as the term "security incident" in 45 C.F.R. § 164.304.
 - (14) "Security Rule" shall mean the Security Standards for the Protection of Electronic Protected Health Information at 45 C.F.R. part 160 and parts 164, subpart A and C.
 - (15) "Unsecured protected health information" shall have the same meaning as the term as defined in section 13402(h)(1)(A) of HITECH. Act. (42 U.S.C. §17932(h)(1)(A)).
- (h) Obligations and Activities of Business Associates.
- (1) Business Associate agrees not to use or disclose PHI other than as permitted or required by this Section of the Contract or as Required by Law.
 - (2) Business Associate agrees to use appropriate safeguards to prevent use or disclosure of PHI other than as provided for in this Section of the Contract.
 - (3) Business Associate agrees to use administrative, physical and technical safeguards that reasonably and appropriately protect the confidentiality, integrity, and availability of electronic protected health information that it creates, receives, maintains, or transmits on behalf of the Covered Entity.
 - (4) Business Associate agrees to mitigate, to the extent practicable, any harmful effect that is known to the Business Associate of a use or disclosure of PHI by Business Associate in violation of this Section of the Contract.

- (5) Business Associate agrees to report to Covered Entity any use or disclosure of PHI not provided for by this Section of the Contract or any security incident of which it becomes aware.
- (6) Business Associate agrees to insure that any agent, including a subcontractor, to whom it provides PHI received from, or created or received by Business Associate, on behalf of the Covered Entity, agrees to the same restrictions and conditions that apply through this Section of the Contract to Business Associate with respect to such information.
- (7) Business Associate agrees to provide access, at the request of the Covered Entity, and in the time and manner agreed to by the parties, to PHI in a Designated Record Set, to Covered Entity or, as directed by Covered Entity, to an Individual in order to meet the requirements under 45 C.F.R. § 164.524.
- (8) Business Associate agrees to make any amendments to PHI in a Designated Record Set that the Covered Entity directs or agrees to pursuant to 45 C.F.R. § 164.526 at the request of the Covered Entity, and in the time and manner agreed to by the parties.
- (9) Business Associate agrees to make internal practices, books, and records, including policies and procedures and PHI, relating to the use and disclosure of PHI received from, or created or received by, Business Associate on behalf of Covered Entity, available to Covered Entity or to the Secretary in a time and manner agreed to by the parties or designated by the Secretary, for purposes of the Secretary determining Covered Entity's compliance with the Privacy Rule.
- (10) Business Associate agrees to document such disclosures of PHI and information related to such disclosures as would be required for Covered Entity to respond to a request by an Individual for an accounting of disclosures of PHI in accordance with 45 C.F.R. § 164.528 and section 13405 of the HITECH Act (42 U.S.C. § 17935) and any regulations promulgated thereunder.
- (11) Business Associate agrees to provide to Covered Entity, in a time and manner agreed to by the parties, information collected in accordance with clause h. (10) of this Section of the Contract, to permit Covered Entity to respond to a request by an Individual for an accounting of disclosures of PHI in accordance with 45 C.F.R. § 164.528 and section 13405 of the HITECH Act (42 U.S.C. § 17935) and any regulations promulgated thereunder. Business Associate agrees at the Covered Entity's direction to provide an accounting of disclosures of PHI directly to an individual in accordance with 45 C.F.R. § 164.528 and section 13405 of the HITECH Act (42 U.S.C. § 17935) and any regulations promulgated thereunder.
- (12) Business Associate agrees to comply with any state or federal law that is more stringent than the Privacy Rule.
- (13) Business Associate agrees to comply with the requirements of the HITECH Act relating to privacy and security that are applicable to the Covered Entity and with the requirements of 45 C.F.R. sections 164.504(e), 164.308, 164.310, 164.312, and 164.316.

- (14) In the event that an individual requests that the Business Associate (a) restrict disclosures of PHI; (b) provide an accounting of disclosures of the individual's PHI; or (c) provide a copy of the individual's PHI in an electronic health record, the Business Associate agrees to notify the covered entity, in writing, within two business days of the request.
- (15) Business Associate agrees that it shall not, directly or indirectly, receive any remuneration in exchange for PHI of an individual without (1) the written approval of the covered entity, unless receipt of remuneration in exchange for PHI is expressly authorized by this Contract and (2) the valid authorization of the individual, except for the purposes provided under section 13405(d)(2) of the HITECH Act,(42 U.S.C. § 17935(d)(2)) and in any accompanying regulations
- (16) Obligations in the Event of a Breach
- A. The Business Associate agrees that, following the discovery of a breach of unsecured protected health information, it shall notify the Covered Entity of such breach in accordance with the requirements of section 13402 of HITECH (42 U.S.C. 17932(b) and the provisions of this Section of the Contract.
- B. Such notification shall be provided by the Business Associate to the Covered Entity without unreasonable delay, and in no case later than 30 days after the breach is discovered by the Business Associate, except as otherwise instructed in writing by a law enforcement official pursuant to section 13402 (g) of HITECH (42 U.S.C. 17932(g)) . A breach is considered discovered as of the first day on which it is, or reasonably should have been, known to the Business Associate. The notification shall include the identification and last known address, phone number and email address of each individual (or the next of kin of the individual if the individual is deceased) whose unsecured protected health information has been, or is reasonably believed by the Business Associate to have been, accessed, acquired, or disclosed during such breach.
- C. The Business Associate agrees to include in the notification to the Covered Entity at least the following information:
1. A brief description of what happened, including the date of the breach and the date of the discovery of the breach, if known.
 2. A description of the types of unsecured protected health information that were involved in the breach (such as full name, Social Security number, date of birth, home address, account number, or disability code).
 3. The steps the Business Associate recommends that individuals take to protect themselves from potential harm resulting from the breach.
 4. A detailed description of what the Business Associate is doing to investigate the breach, to mitigate losses, and to protect against any further breaches.
 5. Whether a law enforcement official has advised either verbally or in writing the Business Associate that he or she has determined that notification or notice to

individuals or the posting required under section 13402 of the HITECH Act would impede a criminal investigation or cause damage to national security and; if so, include contact information for said official.

- D. Business Associate agrees to provide appropriate staffing and have established procedures to ensure that individuals informed by the Covered Entity of a breach by the Business Associate have the opportunity to ask questions and contact the Business Associate for additional information regarding the breach. Such procedures shall include a toll-free telephone number, an e-mail address, a posting on its Web site and a postal address. Business Associate agrees to include in the notification of a breach by the Business Associate to the Covered Entity, a written description of the procedures that have been established to meet these requirements. Costs of such contact procedures will be borne by the Contractor.
 - E. Business Associate agrees that, in the event of a breach, it has the burden to demonstrate that it has complied with all notifications requirements set forth above, including evidence demonstrating the necessity of a delay in notification to the Covered Entity.
- (i) Permitted Uses and Disclosure by Business Associate.
- (1) General Use and Disclosure Provisions Except as otherwise limited in this Section of the Contract, Business Associate may use or disclose PHI to perform functions, activities, or services for, or on behalf of, Covered Entity as specified in this Contract, provided that such use or disclosure would not violate the Privacy Rule if done by Covered Entity or the minimum necessary policies and procedures of the Covered Entity.
 - (2) Specific Use and Disclosure Provisions
 - (A) Except as otherwise limited in this Section of the Contract, Business Associate may use PHI for the proper management and administration of Business Associate or to carry out the legal responsibilities of Business Associate.
 - (B) Except as otherwise limited in this Section of the Contract, Business Associate may disclose PHI for the proper management and administration of Business Associate, provided that disclosures are Required by Law, or Business Associate obtains reasonable assurances from the person to whom the information is disclosed that it will remain confidential and used or further disclosed only as Required by Law or for the purpose for which it was disclosed to the person, and the person notifies Business Associate of any instances of which it is aware in which the confidentiality of the information has been breached.
 - (C) Except as otherwise limited in this Section of the Contract, Business Associate may use PHI to provide Data Aggregation services to Covered Entity as permitted by 45 C.F.R. § 164.504(e)(2)(i)(B).
- (j) Obligations of Covered Entity.

- (1) Covered Entity shall notify Business Associate of any limitations in its notice of privacy practices of Covered Entity, in accordance with 45 C.F.R. § 164.520, or to the extent that such limitation may affect Business Associate's use or disclosure of PHI.
 - (2) Covered Entity shall notify Business Associate of any changes in, or revocation of, permission by Individual to use or disclose PHI, to the extent that such changes may affect Business Associate's use or disclosure of PHI.
 - (3) Covered Entity shall notify Business Associate of any restriction to the use or disclosure of PHI that Covered Entity has agreed to in accordance with 45 C.F.R. § 164.522, to the extent that such restriction may affect Business Associate's use or disclosure of PHI.
- (k) Permissible Requests by Covered Entity. Covered Entity shall not request Business Associate to use or disclose PHI in any manner that would not be permissible under the Privacy Rule if done by the Covered Entity, except that Business Associate may use and disclose PHI for data aggregation, and management and administrative activities of Business Associate, as permitted under this Section of the Contract.
- (l) Term and Termination.
- (1) Term. The Term of this Section of the Contract shall be effective as of the date the Contract is effective and shall terminate when the information collected in accordance with clause h. (10) of this Section of the Contract is provided to the Covered Entity and all of the PHI provided by Covered Entity to Business Associate, or created or received by Business Associate on behalf of Covered Entity, is destroyed or returned to Covered Entity, or, if it is infeasible to return or destroy PHI, protections are extended to such information, in accordance with the termination provisions in this Section.
 - (2) Termination for Cause Upon Covered Entity's knowledge of a material breach by Business Associate, Covered Entity shall either:
 - (A) Provide an opportunity for Business Associate to cure the breach or end the violation and terminate the Contract if Business Associate does not cure the breach or end the violation within the time specified by the Covered Entity; or
 - (B) Immediately terminate the Contract if Business Associate has breached a material term of this Section of the Contract and cure is not possible; or
 - (C) If neither termination nor cure is feasible, Covered Entity shall report the violation to the Secretary.
 - (3) Effect of Termination
 - (A) Except as provided in (l)(2) of this Section of the Contract, upon termination of this Contract, for any reason, Business Associate shall return or destroy all PHI received from Covered Entity, or created or received by Business Associate on behalf of Covered Entity. Business Associate shall also provide the information collected in accordance with clause h. (10) of this Section of the Contract to the Covered Entity

within ten business days of the notice of termination. This provision shall apply to PHI that is in the possession of subcontractors or agents of Business Associate. Business Associate shall retain no copies of the PHI.

(B) In the event that Business Associate determines that returning or destroying the PHI is infeasible, Business Associate shall provide to Covered Entity notification of the conditions that make return or destruction infeasible. Upon documentation by Business Associate that return or destruction of PHI is infeasible, Business Associate shall extend the protections of this Section of the Contract to such PHI and limit further uses and disclosures of PHI to those purposes that make return or destruction infeasible, for as long as Business Associate maintains such PHI. Infeasibility of the return or destruction of PHI includes, but is not limited to, requirements under state or federal law that the Business Associate maintains or preserves the PHI or copies thereof.

(m) Miscellaneous Provisions.

- (1) Regulatory References. A reference in this Section of the Contract to a section in the Privacy Rule means the section as in effect or as amended.
- (2) Amendment. The Parties agree to take such action as is necessary to amend this Section of the Contract from time to time as is necessary for Covered Entity to comply with requirements of the Privacy Rule and the Health Insurance Portability and Accountability Act of 1996, Pub. L. No. 104-191.
- (3) Survival. The respective rights and obligations of Business Associate shall survive the termination of this Contract.
- (4) Effect on Contract. Except as specifically required to implement the purposes of this Section of the Contract, all other terms of the Contract shall remain in force and effect.
- (5) Construction. This Section of the Contract shall be construed as broadly as necessary to implement and comply with the Privacy Standard. Any ambiguity in this Section of the Contract shall be resolved in favor of a meaning that complies, and is consistent with, the Privacy Standard.
- (6) Disclaimer. Covered Entity makes no warranty or representation that compliance with this Section of the Contract will be adequate or satisfactory for Business Associate's own purposes. Covered Entity shall not be liable to Business Associate for any claim, civil or criminal penalty, loss or damage related to or arising from the unauthorized use or disclosure of PHI by Business Associate or any of its officers, directors, employees, contractors or agents, or any third party to whom Business Associate has disclosed PHI contrary to the provisions of this Contract or applicable law. Business Associate is solely responsible for all decisions made, and actions taken, by Business Associate regarding the safeguarding, use and disclosure of PHI within its possession, custody or control.

(7) Indemnification. The Business Associate shall indemnify and hold the Covered Entity harmless from and against any and all claims, liabilities, judgments, fines, assessments, penalties, awards and any statutory damages that may be imposed or assessed pursuant to HIPAA, as amended or the

HITECH Act, including, without limitation, attorney's fees, expert witness fees, costs of investigation, litigation or dispute resolution, and costs awarded thereunder, relating to or arising out of any violation by the Business Associate and its agents, including subcontractors, of any obligation of Business Associate and its agents, including subcontractors, under this section of the contract, under HIPAA, the HITECH Act, the Privacy Rule and the Security Rule.

Notice to Executive Branch State Contractors and Prospective State Contractors of Campaign Contribution and Solicitation Limitations

This notice is provided under the authority of Connecticut General Statutes §9-612(g)(2), as amended by P.A. 10-1, and is for the purpose of informing state contractors and prospective state contractors of the following law (*italicized words are defined on the reverse side of this page*).

CAMPAIGN CONTRIBUTION AND SOLICITATION LIMITATIONS

No *state contractor, prospective state contractor, principal of a state contractor or principal of a prospective state contractor*, with regard to a *state contract or state contract solicitation* with or from a state agency in the executive branch or a quasi-public agency or a holder, or principal of a holder of a valid prequalification certificate, shall make a contribution to (i) an exploratory committee or candidate committee established by a candidate for nomination or election to the office of Governor, Lieutenant Governor, Attorney General, State Comptroller, Secretary of the State or State Treasurer, (ii) a political committee authorized to make contributions or expenditures to or for the benefit of such candidates, or (iii) a party committee (which includes town committees).

In addition, no holder or principal of a holder of a valid prequalification certificate, shall make a contribution to (i) an exploratory committee or candidate committee established by a candidate for nomination or election to the office of State senator or State representative, (ii) a political committee authorized to make contributions or expenditures to or for the benefit of such candidates, or (iii) a party committee.

On and after January 1, 2011, no state contractor, prospective state contractor, principal of a state contractor or principal of a prospective state contractor, with regard to a state contract or state contract solicitation with or from a state agency in the executive branch or a quasi-public agency or a holder, or principal of a holder of a valid prequalification certificate, shall **knowingly solicit** contributions from the state contractor's or prospective state contractor's employees or from a *subcontractor or principals of the subcontractor* on behalf of (i) an exploratory committee or candidate committee established by a candidate for nomination or election to the office of Governor, Lieutenant Governor, Attorney General, State Comptroller, Secretary of the State or State Treasurer, (ii) a political committee authorized to make contributions or expenditures to or for the benefit of such candidates, or (iii) a party committee.

DUTY TO INFORM

State contractors and prospective state contractors are required to inform their principals of the above prohibitions, as applicable, and the possible penalties and other consequences of any violation thereof.

PENALTIES FOR VIOLATIONS

Contributions or solicitations of contributions made in violation of the above prohibitions may result in the following civil and criminal penalties:

Civil penalties—Up to \$2,000 or twice the amount of the prohibited contribution, whichever is greater, against a principal or a contractor. Any state contractor or prospective state contractor which fails to make reasonable efforts to comply with the provisions requiring notice to its principals of these prohibitions and the possible consequences of their violations may also be subject to civil penalties of up to \$2,000 or twice the amount of the prohibited contributions made by their principals.

Criminal penalties—Any knowing and willful violation of the prohibition is a Class D felony, which may subject the violator to imprisonment of not more than 5 years, or not more than \$5,000 in fines, or both.

CONTRACT CONSEQUENCES

In the case of a state contractor, contributions made or solicited in violation of the above prohibitions may result in the contract being voided.

In the case of a prospective state contractor, contributions made or solicited in violation of the above prohibitions shall result in the contract described in the state contract solicitation not being awarded to the prospective state contractor, unless the State Elections Enforcement Commission determines that mitigating circumstances exist concerning such violation.

The State shall not award any other state contract to anyone found in violation of the above prohibitions for a period of one year after the election for which such contribution is made or solicited, unless the State Elections Enforcement Commission determines that mitigating circumstances exist concerning such violation.

Additional information may be found on the website of the State Elections Enforcement Commission, www.ct.gov/seec. Click on the link to "Lobbyist/Contractor Limitations."

DEFINITIONS

“State contractor” means a person, business entity or nonprofit organization that enters into a state contract. Such person, business entity or nonprofit organization shall be deemed to be a state contractor until December thirty-first of the year in which such contract terminates. “State contractor” does not include a municipality or any other political subdivision of the state, including any entities or associations duly created by the municipality or political subdivision exclusively amongst themselves to further any purpose authorized by statute or charter, or an employee in the executive or legislative branch of state government or a quasi-public agency, whether in the classified or unclassified service and full or part-time, and only in such person's capacity as a state or quasi-public agency employee.

“Prospective state contractor” means a person, business entity or nonprofit organization that (i) submits a response to a state contract solicitation by the state, a state agency or a quasi-public agency, or a proposal in response to a request for proposals by the state, a state agency or a quasi-public agency, until the contract has been entered into, or (ii) holds a valid prequalification certificate issued by the Commissioner of Administrative Services under section 4a-100. “Prospective state contractor” does not include a municipality or any other political subdivision of the state, including any entities or associations duly created by the municipality or political subdivision exclusively amongst themselves to further any purpose authorized by statute or charter, or an employee in the executive or legislative branch of state government or a quasi-public agency, whether in the classified or unclassified service and full or part-time, and only in such person's capacity as a state or quasi-public agency employee.

“Principal of a state contractor or prospective state contractor” means (i) any individual who is a member of the board of directors of, or has an ownership interest of five per cent or more in, a state contractor or prospective state contractor, which is a business entity, except for an individual who is a member of the board of directors of a nonprofit organization, (ii) an individual who is employed by a state contractor or prospective state contractor, which is a business entity, as president, treasurer or executive vice president, (iii) an individual who is the chief executive officer of a state contractor or prospective state contractor, which is not a business entity, or if a state contractor or prospective state contractor has no such officer, then the officer who duly possesses comparable powers and duties, (iv) an officer or an employee of any state contractor or prospective state contractor who has *managerial or discretionary responsibilities with respect to a state contract*, (v) the spouse or a *dependent child* who is eighteen years of age or older of an individual described in this subparagraph, or (vi) a political committee established or controlled by an individual described in this subparagraph or the business entity or nonprofit organization that is the state contractor or prospective state contractor.

“State contract” means an agreement or contract with the state or any state agency or any quasi-public agency, let through a procurement process or otherwise, having a value of fifty thousand dollars or more, or a combination or series of such agreements or contracts having a value of one hundred thousand dollars or more in a calendar year, for (i) the rendition of services, (ii) the furnishing of any goods, material, supplies, equipment or any items of any kind, (iii) the construction, alteration or repair of any public building or public work, (iv) the acquisition, sale or lease of any land or building, (v) a licensing arrangement, or (vi) a grant, loan or loan guarantee. “State contract” does not include any agreement or contract with the state, any state agency or any quasi-public agency that is exclusively federally funded, an education loan, a loan to an individual for other than commercial purposes or any agreement or contract between the state or any state agency and the United States Department of the Navy or the United States Department of Defense.

“State contract solicitation” means a request by a state agency or quasi-public agency, in whatever form issued, including, but not limited to, an invitation to bid, request for proposals, request for information or request for quotes, inviting bids, quotes or other types of submittals, through a competitive procurement process or another process authorized by law waiving competitive procurement.

“Managerial or discretionary responsibilities with respect to a state contract” means having direct, extensive and substantive responsibilities with respect to the negotiation of the state contract and not peripheral, clerical or ministerial responsibilities.

“Dependent child” means a child residing in an individual's household who may legally be claimed as a dependent on the federal income tax of such individual.

“Solicit” means (A) requesting that a contribution be made, (B) participating in any fund-raising activities for a candidate committee, exploratory committee, political committee or party committee, including, but not limited to, forwarding tickets to potential contributors, receiving contributions for transmission to any such committee or bundling contributions, (C) serving as chairperson, treasurer or deputy treasurer of any such committee, or (D) establishing a political committee for the sole purpose of soliciting or receiving contributions for any committee. Solicit does not include: (i) making a contribution that is otherwise permitted by Chapter 155 of the Connecticut General Statutes; (ii) informing any person of a position taken by a candidate for public office or a public official, (iii) notifying the person of any activities of, or contact information for, any candidate for public office; or (iv) serving as a member in any party committee or as an officer of such committee that is not otherwise prohibited in this section.

“Subcontractor” means any person, business entity or nonprofit organization that contracts to perform part or all of the obligations of a state contractor's state contract. Such person, business entity or nonprofit organization shall be deemed to be a subcontractor until December thirty first of the year in which the subcontract terminates. “Subcontractor” does not include (i) a municipality or any other political subdivision of the state, including any entities or associations duly created by the municipality or political subdivision exclusively amongst themselves to further any purpose authorized by statute or charter, or (ii) an employee in the executive or legislative branch of state government or a quasi-public agency, whether in the classified or unclassified service and full or part-time, and only in such person's capacity as a state or quasi-public agency employee.

“Principal of a subcontractor” means (i) any individual who is a member of the board of directors of, or has an ownership interest of five per cent or more in, a subcontractor, which is a business entity, except for an individual who is a member of the board of directors of a nonprofit organization, (ii) an individual who is employed by a subcontractor, which is a business entity, as president, treasurer or executive vice president, (iii) an individual who is the chief executive officer of a subcontractor, which is not a business entity, or if a subcontractor has no such officer, then the officer who duly possesses comparable powers and duties, (iv) an officer or an employee of any subcontractor who has managerial or discretionary responsibilities with respect to a subcontract with a state contractor, (v) the spouse or a dependent child who is eighteen years of age or older of an individual described in this subparagraph, or (vi) a political committee established or controlled by an individual described in this subparagraph or the business entity or nonprofit organization that is the subcontractor.

EXHIBIT F

(federal wage rate package will be inserted here for final executed contract only. Refer to NTC – Federal Wage Determinations)

EXHIBIT G

(state wages will be inserted here)

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

**Minimum Rates and Classifications
for Building Construction**

ID# : B 24631

**Connecticut Department of Labor
Wage and Workplace Standards Division**

By virtue of the authority vested in the Labor Commissioner under provisions of Section 31-53 of the General Statutes of Connecticut, as amended, the following are declared to be the prevailing rates and welfare payments and will apply only where the contract is advertised for bid within 20 days of the date on which the rates are established. Any contractor or subcontractor not obligated by agreement to pay to the welfare and pension fund shall pay this amount to each employee as part of his/her hourly wages.

Project Number:

Project Town: Newington

State#: 93-210

FAP#: 1093(119)

Project: Newington Department Of Transportation Highway Operations Center
Expansion And Renovation

CLASSIFICATION	Hourly Rate	Benefits
1a) Asbestos Worker/Insulator (Includes application of insulating materials, protective coverings, coatings, & finishes to all types of mechanical systems; application of firestopping material for wall openings & penetrations in walls, floors, ceilings	38.25	27.96
<hr/>		
1b) Asbestos/Toxic Waste Removal Laborers: Asbestos removal and encapsulation (except its removal from mechanical systems which are not to be scrapped), toxic waste removers, blasters.**See Laborers Group 7**		
<hr/>		
1c) Asbestos Worker/Heat and Frost Insulator	39.00	28.76

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

2) Boilermaker	38.34	26.01
----------------	-------	-------

3a) Bricklayer, Cement Mason, Concrete Finisher (including caulking), Stone Masons	33.48	32.06 + a
---	-------	-----------

3b) Tile Setter	34.90	25.87
-----------------	-------	-------

3c) Terrazzo Mechanics and Marble Setters	31.69	22.35
---	-------	-------

3d) Tile, Marble & Terrazzo Finishers	26.70	21.75
---------------------------------------	-------	-------

3e) Plasterer	33.48	32.06
---------------	-------	-------

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

-----LABORERS-----

4) Group 1: Laborers (common or general), acetylene burners, carpenter tenders, concrete specialists, wrecking laborers, fire watchers.	29.25	19.50
---	-------	-------

4a) Group 2: Mortar mixers, plaster tender, power buggy operators, powdermen, fireproofers/mixer/nozzleman (Person running mixer and spraying fireproof only).	29.50	19.50
--	-------	-------

4b) Group 3: Jackhammer operators/pavement breaker, mason tender (brick), mason tender (cement/concrete), forklift operators and forklift operators (masonry).	29.75	19.50
--	-------	-------

4c) **Group 4: Pipelayers (Installation of water, storm drainage or sewage lines outside of the building line with P6, P7 license) (the pipelayer rate shall apply only to one or two employees of the total crew who primary task is to actually perform the mating of pipe sections) P6 and P7 rate is \$26.80.	29.75	19.50
---	-------	-------

4d) Group 5: Air track operator, sand blaster and hydraulic drills.	29.75	19.50
---	-------	-------

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

4e) Group 6: Blasters, nuclear and toxic waste removal. 31.00 19.50

4f) Group 7: Asbestos/lead removal and encapsulation (except it's removal from mechanical systems which are not to be scrapped). 30.25 19.50

4g) Group 8: Bottom men on open air caisson, cylindrical work and boring crew. 28.38 19.50

4h) Group 9: Top men on open air caisson, cylindrical work and boring crew. 27.86 19.50

4i) Group 10: Traffic Control Signalman 16.00 19.50

5) Carpenter, Acoustical Ceiling Installation, Soft Floor/Carpet Laying, Metal Stud Installation, Form Work and Scaffold Building, Drywall Hanging, Modular-Furniture Systems Installers, Lathers, Piledrivers, Resilient Floor Layers. 32.60 25.34

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

5a) Millwrights 33.14 25.74

6) Electrical Worker (including low voltage wiring) (Trade License
required: E1,2 L-5,6 C-5,6 T-1,2 L-1,2 V-1,2,7,8,9) 37.50 26.31+3% of
gross wage

7a) Elevator Mechanic (Trade License required: R-1,2,5,6) 51.71 32.645+a+b

-----LINE CONSTRUCTION-----

Groundman 26.50 6.5% + 9.00

Linemen/Cable Splicer 48.19 6.5% + 22.00

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

8) Glazier (Trade License required: FG-1,2) 36.28 20.45 + a

9) Ironworker, Ornamental, Reinforcing, Structural, and Precast Concrete
Erection 35.47 33.39 + a

----OPERATORS----

Group 1: Crane handling or erecting structural steel or stone, hoisting
engineer 2 drums or over, front end loader (7 cubic yards or over), work
boat 26 ft. and over and Tunnel Boring Machines. (Trade License Required) 39.30 24.05 + a

Group 2: Cranes (100 ton rate capacity and over); Excavator over 2 cubic
yards; Piledriver (\$3.00 premium when operator controls hammer); Bauer
Drill/Caisson. (Trade License Required) 38.98 24.05 + a

Group 3: Excavator; Backhoe/Excavator under 2 cubic yards; Cranes
(under 100 ton rated capacity), Grader/Blade; Master Mechanic; Hoisting
Engineer (all types of equipment where a drum and cable are used to hoist
or drag material regardless of motive power of operation), Rubber Tire
Excavator (Drott-1085 or similar); Grader Operator; Bulldozer Fine Grade.
(slopes, shaping, laser or GPS, etc.). (Trade License Required) 38.24 24.05 + a

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

Group 4: Trenching Machines; Lighter Derrick; Concrete Finishing Machine; CMI Machine or Similar; Koehring Loader (Skooper).	37.85	24.05 + a
--	-------	-----------

Group 5: Specialty Railroad Equipment; Asphalt Paver; Asphalt Reclaiming Machine; Line Grinder; Concrete Pumps; Drills with Self Contained Power Units; Boring Machine; Post Hole Digger; Auger; Pounder; Well Digger; Milling Machine (over 24" Mandrell)	37.26	24.05 + a
--	-------	-----------

Group 5 continued: Side Boom; Combination Hoe and Loader; Directional Driller; Pile Testing Machine.	37.26	24.05 + a
--	-------	-----------

Group 6: Front End Loader (3 up to 7 cubic yards); Bulldozer (rough grade dozer).	36.95	24.05 + a
---	-------	-----------

Group 7: Asphalt roller, concrete saws and cutters (ride on types), vermeer concrete cutter, Stump Grinder; Scraper; Snooper; Skidder; Milling Machine (24" and under Mandrell).	36.61	24.05 + a
--	-------	-----------

Group 8: Mechanic, grease truck operator, hydroblaster; barrier mover; power stone spreader; welding; work boat under 26 ft.; transfer machine.	36.21	24.05 + a
---	-------	-----------

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

Group 9: Front end loader (under 3 cubic yards), skid steer loader
regardless of attachments, (Bobcat or Similar): forklift, power chipper;
landscape equipment (including Hydroseeder). 35.78 24.05 + a

Group 10: Vibratory hammer; ice machine; diesel and air, hammer, etc. 33.74 24.05 + a

Group 11: Conveyor, earth roller, power pavement breaker (whiphammer),
robot demolition equipment. 33.74 24.05 + a

Group 12: Wellpoint operator. 33.68 24.05 + a

Group 13: Compressor battery operator. 33.10 24.05 + a

Group 14: Elevator operator; tow motor operator (solid tire no rough
terrain). 31.96 24.05 + a

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

Group 15: Generator Operator; Compressor Operator; Pump Operator; Welding Machine Operator; Heater Operator. 31.55 24.05 + a

Group 16: Maintenance Engineer/Oiler. 30.90 24.05 + a

Group 17: Portable asphalt plant operator; portable crusher plant operator; portable concrete plant operator. 35.21 24.05 + a

Group 18: Power safety boat; vacuum truck; zim mixer; sweeper; (Minimum for any job requiring a CDL license). 32.79 24.05 + a

-----PAINTERS (Including Drywall Finishing)-----

10a) Brush and Roller 32.72 20.45

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

10b) Taping Only/Drywall Finishing	33.47	20.45
------------------------------------	-------	-------

10c) Paperhanger and Red Label	33.22	20.45
--------------------------------	-------	-------

10e) Blast and Spray	35.72	20.45
----------------------	-------	-------

11) Plumber (excluding HVAC pipe installation) (Trade License required: P-1,2,6,7,8,9 J-1,2,3,4 SP-1,2)	41.62	30.36
--	-------	-------

12) Well Digger, Pile Testing Machine	33.01	19.40 + a
---------------------------------------	-------	-----------

13) Roofer (composition)	35.97	19.73
--------------------------	-------	-------

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

14) Roofer (slate & tile)	36.47	19.73
---------------------------	-------	-------

15) Sheetmetal Worker (Trade License required for HVAC and Ductwork: SM-1,SM-2,SM-3,SM-4,SM-5,SM-6)	37.18	34.29
--	-------	-------

16) Pipefitter (Including HVAC work) (Trade License required: S-1,2,3,4,5,6,7,8 B-1,2,3,4 D-1,2,3,4, G-1, G-2, G-8 & G-9)	41.62	30.36
---	-------	-------

-----TRUCK DRIVERS-----

17a) 2 Axle	29.13	22.32 + a
-------------	-------	-----------

17b) 3 Axle, 2 Axle Ready Mix	29.23	22.32 + a
-------------------------------	-------	-----------

As of: **Friday, April 06, 2018**

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

17c) 3 Axle Ready Mix	29.28	22.32 + a
-----------------------	-------	-----------

17d) 4 Axle, Heavy Duty Trailer up to 40 tons	29.33	22.32 + a
---	-------	-----------

17e) 4 Axle Ready Mix	29.38	22.32 + a
-----------------------	-------	-----------

17f) Heavy Duty Trailer (40 Tons and Over)	29.58	22.32 + a
--	-------	-----------

17g) Specialized Earth Moving Equipment (Other Than Conventional Type on-the-Road Trucks and Semi-Trailers, Including Euclids)	29.38	22.32 + a
---	-------	-----------

18) Sprinkler Fitter (Trade License required: F-1,2,3,4)	43.92	15.84 + a
--	-------	-----------

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

19) Theatrical Stage Journeyman	25.76	7.34
---------------------------------	-------	------

**Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation**

Welders: Rate for craft to which welding is incidental.

**Note: Hazardous waste removal work receives additional \$1.25 per hour for truck drivers.*

***Note: Hazardous waste premium \$3.00 per hour over classified rate*

ALL Cranes: When crane operator is operating equipment that requires a fully licensed crane operator to operate he receives an extra \$4.00 premium in addition to the hourly wage rate and benefit contributions:

1) Crane handling or erecting structural steel or stone; hoisting engineer (2 drums or over)

2) Cranes (100 ton rate capacity and over) Bauer Drill/Caisson

3) Cranes (under 100 ton rated capacity)

Crane with 150 ft. boom (including jib) - \$1.50 extra

Crane with 200 ft. boom (including jib) - \$2.50 extra

Crane with 250 ft. boom (including jib) - \$5.00 extra

Crane with 300 ft. boom (including jib) - \$7.00 extra

Crane with 400 ft. boom (including jib) - \$10.00 extra

All classifications that indicate a percentage of the fringe benefits must be calculated at the percentage rate times the "base hourly rate".

Apprentices duly registered under the Commissioner of Labor's regulations on "Work Training Standards for Apprenticeship and Training Programs" Section 31-51-d-1 to 12, are allowed to be paid the appropriate percentage of the prevailing journeymen hourly base and the full fringe benefit rate, providing the work site ratio shall not be less than one full-time journeyman instructing and supervising the work of each apprentice in a specific trade.

The Prevailing wage rates applicable to this project are subject to annual adjustments each July 1st for the duration of the project.

Each contractor shall pay the annual adjusted prevailing wage rate that is in effect each July 1st, as posted by the Department of Labor.

It is the contractor's responsibility to obtain the annual adjusted prevailing wage rate increases directly from the Department of Labor's website.

The annual adjustments will be posted on the Department of Labor's Web page: www.ct.gov/dol. For those without internet access, please contact the division listed below.

The Department of Labor will continue to issue the initial prevailing wage rate schedule to the Contracting Agency for the project.

All subsequent annual adjustments will be posted on our Web Site for contractor access.

Contracting Agencies are under no obligation pursuant to State labor law to pay any increase due to the annual adjustment provision.

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion
And Renovation

Effective October 1, 2005 - Public Act 05-50: any person performing the work of any mechanic, laborer, or worker shall be paid prevailing wage

All Person who perform work ON SITE must be paid prevailing wage for the appropriate mechanic, laborer, or worker classification.

All certified payrolls must list the hours worked and wages paid to All Persons who perform work ON SITE regardless of their ownership i.e.: (Owners, Corporate Officers, LLC Members, Independent Contractors, et. al)

Reporting and payment of wages is required regardless of any contractual relationship alleged to exist between the contractor and such person.

~~Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clause (29 CFR 5.5 (a) (1) (ii)).

Please direct any questions which you may have pertaining to classification of work and payment of prevailing wages to the Wage and Workplace Standards Division, telephone (860)263-6790.

As of: Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And Renovation

**Minimum Rates and Classifications
for Heavy/Highway Construction**

**Connecticut Department of Labor
Wage and Workplace Standards Division**

ID#: H 24631

By virtue of the authority vested in the Labor Commissioner under provisions of Section 31-53 of the General Statutes of Connecticut, as amended, the following are declared to be the prevailing rates and welfare payments and will apply only where the contract is advertised for bid within 20 days of the date on which the rates are established. Any contractor or subcontractor not obligated by agreement to pay to the welfare and pension fund shall pay this amount to each employee as part of his/her hourly wages.

Project Number:

Project Town: Newington

FAP Number: 1093(119)

State Number: 93-210

Project: Newington Department Of Transportation Highway Operations Center Expansion And Renovation

CLASSIFICATION	Hourly Rate	Benefits
-----------------------	--------------------	-----------------

01) Asbestos/Toxic Waste Removal Laborers: Asbestos removal and encapsulation (except its removal from mechanical systems which are not to be scrapped), toxic waste removers, blasters. **See Laborers Group 5 and 7**

1) Boilermaker	33.79	34% + 8.96
----------------	-------	------------

1a) Bricklayer, Cement Masons, Cement Finishers, Plasterers, Stone Masons	33.48	31.66
---	-------	-------

2) Carpenters, Piledrivermen	32.60	25.34
------------------------------	-------	-------

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And
Renovation

2a) Diver Tenders	32.60	25.34
-------------------	-------	-------

3) Divers	41.06	25.34
-----------	-------	-------

03a) Millwrights	33.14	25.74
------------------	-------	-------

4) Painters: (Bridge Construction) Brush, Roller, Blasting (Sand, Water, etc.), Spray	48.55	20.45
--	-------	-------

4a) Painters: Brush and Roller	32.72	20.45
--------------------------------	-------	-------

4b) Painters: Spray Only	35.72	20.45
--------------------------	-------	-------

4c) Painters: Steel Only	34.72	20.45
--------------------------	-------	-------

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And
Renovation

4d) Painters: Blast and Spray 35.72 20.45

4e) Painters: Tanks, Tower and Swing 34.72 20.45

5) Electrician (Trade License required: E-1,2 L-5,6 C-5,6 T-1,2 L-1,2 V-1,2,7,8,9) 37.50 26.31+3% of gross wage

6) Ironworkers: Ornamental, Reinforcing, Structural, and Precast Concrete Erection 35.47 33.39 + a

7) Plumbers (Trade License required: (P-1,2,6,7,8,9 J-1,2,3,4 SP-1,2) and Pipefitters (Including HVAC Work) (Trade License required: S-1,2,3,4,5,6,7,8 B-1,2,3,4 D-1,2,3,4 G-1, G-2, G-8, G-9) 41.62 30.36

---LABORERS----

8) Group 1: Laborer (Unskilled), Common or General, acetylene burner, concrete specialist 29.25 19.50

Project: Newington Department Of Transportation Highway Operations Center Expansion And Renovation

9) Group 2: Chain saw operators, fence and guard rail erectors, pneumatic tool operators, powdermen	29.50	19.50
---	-------	-------

10) Group 3: Pipelayers	29.75	19.50
-------------------------	-------	-------

11) Group 4: Jackhammer/Pavement breaker (handheld); mason tenders (cement/concrete), catch basin builders, asphalt rakers, air track operators, block paver, curb setter and forklift operators	29.75	19.50
--	-------	-------

12) Group 5: Toxic waste removal (non-mechanical systems)	31.25	19.50
---	-------	-------

13) Group 6: Blasters	31.00	19.50
-----------------------	-------	-------

Group 7: Asbestos/lead removal, non-mechanical systems (does not include leaded joint pipe)	30.25	19.50
---	-------	-------

Group 8: Traffic control signalmen	16.00	19.50
------------------------------------	-------	-------

Project: Newington Department Of Transportation Highway Operations Center Expansion And Renovation

Group 9: Hydraulic Drills	29.30	18.90
---------------------------	-------	-------

---LABORERS (TUNNEL CONSTRUCTION, FREE AIR). Shield Drive and Liner Plate Tunnels in Free Air.---

13a) Miners, Motormen, Mucking Machine Operators, Nozzle Men, Grout Men, Shaft & Tunnel Steel & Rodmen, Shield & Erector, Arm Operator, Cable Tenders	32.22	19.50 + a
---	-------	-----------

13b) Brakemen, Trackmen	31.28	19.50 + a
-------------------------	-------	-----------

---CLEANING, CONCRETE AND CAULKING TUNNEL---

14) Concrete Workers, Form Movers, and Strippers	31.28	19.50 + a
--	-------	-----------

15) Form Erectors	31.60	19.50 + a
-------------------	-------	-----------

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And
Renovation

---ROCK SHAFT LINING, CONCRETE, LINING OF SAME AND TUNNEL
IN FREE AIR:----

16) Brakemen, Trackmen, Tunnel Laborers, Shaft Laborers	31.28	19.50 + a
---	-------	-----------

17) Laborers Topside, Cage Tenders, Bellman	31.17	19.50 + a
---	-------	-----------

18) Miners	32.22	19.50 + a
------------	-------	-----------

---TUNNELS, CAISSON AND CYLINDER WORK IN COMPRESSED
AIR: ----

18a) Blaster	38.53	19.50 + a
--------------	-------	-----------

19) Brakemen, Trackmen, Groutman, Laborers, Outside Lock Tender, Gauge Tenders	38.34	19.50 + a
---	-------	-----------

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And Renovation

20) Change House Attendants, Powder Watchmen, Top on Iron Bolts 36.41 19.50 + a

21) Mucking Machine Operator 39.11 19.50 + a

---TRUCK DRIVERS---(*see note below)

Two axle trucks 29.13 22.32 + a

Three axle trucks; two axle ready mix 29.23 22.32 + a

Three axle ready mix 29.28 22.32 + a

Four axle trucks, heavy duty trailer (up to 40 tons) 29.33 22.32 + a

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And
Renovation

Four axle ready-mix	29.38	22.32 + a
---------------------	-------	-----------

Heavy duty trailer (40 tons and over)	29.58	22.32 + a
---------------------------------------	-------	-----------

Specialized earth moving equipment other than conventional type on-the road trucks and semi-trailer (including Euclids)	29.38	22.32 + a
---	-------	-----------

---POWER EQUIPMENT OPERATORS---

Group 1: Crane handling or erecting structural steel or stone, hoisting engineer (2 drums or over), front end loader (7 cubic yards or over), Work Boat 26 ft. & Over, Tunnel Boring Machines. (Trade License Required)	39.30	24.05 + a
---	-------	-----------

Group 2: Cranes (100 ton rate capacity and over); Excavator over 2 cubic yards; Piledriver (\$3.00 premium when operator controls hammer); Bauer Drill/Caisson. (Trade License Required)	38.98	24.05 + a
--	-------	-----------

Group 3: Excavator/Backhoe under 2 cubic yards; Cranes (under 100 ton rated capacity), Gradall; Master Mechanic; Hoisting Engineer (all types of equipment where a drum and cable are used to hoist or drag material regardless of motive power of operation), Rubber Tire Excavator (Drott-1085 or similar); Grader Operator; Bulldozer Fine Grade (slopes, shaping, laser or GPS, etc.). (Trade License Required)	38.24	24.05 + a
---	-------	-----------

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And
Renovation

Group 4: Trenching Machines; Lighter Derrick; Concrete Finishing Machine;
CMI Machine or Similar; Koehring Loader (Skooper) 37.85 24.05 + a

Group 5: Specialty Railroad Equipment; Asphalt Paver; Asphalt Spreader;
Asphalt Reclaiming Machine; Line Grinder; Concrete Pumps; Drills with Self
Contained Power Units; Boring Machine; Post Hole Digger; Auger; Pounder;
Well Digger; Milling Machine (over 24" Mandrell) 37.26 24.05 + a

Group 5 continued: Side Boom; Combination Hoe and Loader; Directional
Driller. 37.26 24.05 + a

Group 6: Front End Loader (3 up to 7 cubic yards); Bulldozer (rough grade
dozer). 36.95 24.05 + a

Group 7: Asphalt Roller; Concrete Saws and Cutters (ride on types); Vermeer
Concrete Cutter; Stump Grinder; Scraper; Snooper; Skidder; Milling Machine
(24" and Under Mandrel). 36.61 24.05 + a

Group 8: Mechanic, Grease Truck Operator, Hydroblaster, Barrier Mover,
Power Stone Spreader; Welder; Work Boat under 26 ft.; Transfer Machine. 36.21 24.05 + a

Group 9: Front End Loader (under 3 cubic yards), Skid Steer Loader regardless
of attachments (Bobcat or Similar); Fork Lift, Power Chipper; Landscape
Equipment (including hydroseeder). 35.78 24.05 + a

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And
Renovation

Group 10: Vibratory Hammer, Ice Machine, Diesel and Air Hammer, etc. 33.74 24.05 + a

Group 11: Conveyor, Earth Roller; Power Pavement Breaker (whiphammer),
Robot Demolition Equipment. 33.74 24.05 + a

Group 12: Wellpoint Operator. 33.68 24.05 + a

Group 13: Compressor Battery Operator. 33.10 24.05 + a

Group 14: Elevator Operator; Tow Motor Operator (Solid Tire No Rough
Terrain). 31.96 24.05 + a

Group 15: Generator Operator; Compressor Operator; Pump Operator; Welding
Machine Operator; Heater Operator. 31.55 24.05 + a

Group 16: Maintenance Engineer/Oiler 30.90 24.05 + a

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And
Renovation

Group 17: Portable asphalt plant operator; portable crusher plant operator; 35.21 24.05 + a
portable concrete plant operator.

Group 18: Power Safety Boat; Vacuum Truck; Zim Mixer; Sweeper; (minimum 32.79 24.05 + a
for any job requiring CDL license).

**NOTE: SEE BELOW

---LINE CONSTRUCTION---(Railroad Construction and Maintenance)---

20) Lineman, Cable Splicer, Technician 48.19 6.5% + 22.00

21) Heavy Equipment Operator 42.26 6.5% + 19.88

22) Equipment Operator, Tractor Trailer Driver, Material Men 40.96 6.5% + 19.21

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And
Renovation

23) Driver Groundmen 26.50 6.5% + 9.00

23a) Truck Driver 40.96 6.5% + 17.76

---LINE CONSTRUCTION---

24) Driver Groundmen 30.92 6.5% + 9.70

25) Groundmen 22.67 6.5% + 6.20

26) Heavy Equipment Operators 37.10 6.5% + 10.70

27) Linemen, Cable Splicers, Dynamite Men 41.22 6.5% + 12.20

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And
Renovation

28) Material Men, Tractor Trailer Drivers, Equipment Operators 35.04 6.5% + 10.45

Project: Newington Department Of Transportation Highway Operations Center Expansion And Renovation

Welders: Rate for craft to which welding is incidental.

**Note: Hazardous waste removal work receives additional \$1.25 per hour for truck drivers.*

***Note: Hazardous waste premium \$3.00 per hour over classified rate*

ALL Cranes: When crane operator is operating equipment that requires a fully licensed crane operator to operate he receives an extra \$4.00 premium in addition to the hourly wage rate and benefit contributions:

1) Crane handling or erecting structural steel or stone; hoisting engineer (2 drums or over)

2) Cranes (100 ton rate capacity and over) Bauer Drill/Caisson

3) Cranes (under 100 ton rated capacity)

Crane with 150 ft. boom (including jib) - \$1.50 extra

Crane with 200 ft. boom (including jib) - \$2.50 extra

Crane with 250 ft. boom (including jib) - \$5.00 extra

Crane with 300 ft. boom (including jib) - \$7.00 extra

Crane with 400 ft. boom (including jib) - \$10.00 extra

All classifications that indicate a percentage of the fringe benefits must be calculated at the percentage rate times the "base hourly rate".

Apprentices duly registered under the Commissioner of Labor's regulations on "Work Training Standards for Apprenticeship and Training Programs" Section 31-51-d-1 to 12, are allowed to be paid the appropriate percentage of the prevailing journeymen hourly base and the full fringe benefit rate, providing the work site ratio shall not be less than one full-time journeyman instructing and supervising the work of each apprentice in a specific trade.

~~Connecticut General Statute Section 31-55a: Annual Adjustments to wage rates by contractors doing state work ~~

The Prevailing wage rates applicable to this project are subject to annual adjustments each July 1st for the duration of the project.

Each contractor shall pay the annual adjusted prevailing wage rate that is in effect each July 1st, as posted by the Department of Labor.

It is the contractor's responsibility to obtain the annual adjusted prevailing wage rate increases directly from the Department of Labor's website.

The annual adjustments will be posted on the Department of Labor's Web page: www.ct.gov/dol.

The Department of Labor will continue to issue the initial prevailing wage rate schedule to the Contracting Agency for the project.

All subsequent annual adjustments will be posted on our Web Site for contractor access.

Contracting Agencies are under no obligation pursuant to State labor law to pay any increase due to the annual adjustment provision.

As of:

Friday, April 06, 2018

Project: Newington Department Of Transportation Highway Operations Center Expansion And Renovation

Effective October 1, 2005 - Public Act 05-50: any person performing the work of any mechanic, laborer, or worker shall be paid prevailing wage

All Person who perform work ON SITE must be paid prevailing wage for the appropriate mechanic, laborer, or worker classification.

All certified payrolls must list the hours worked and wages paid to All Persons who perform work ON SITE regardless of their ownership i.e.: (Owners, Corporate Officers, LLC Members, Independent Contractors, et. al)

Reporting and payment of wages is required regardless of any contractual relationship alleged to exist between the contractor and such person.

~~Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clause (29 CFR 5.5 (a) (1) (ii)).

Please direct any questions which you may have pertaining to classification of work and payment of prevailing wages to the Wage and Workplace Standards Division, telephone (860)263-6790.

As of:

Friday, April 06, 2018

Connecticut Department of Labor
Wage and Workplace Standards Division
FOOTNOTES

Please Note: If the “Benefits” listed on the schedule for the following occupations includes a letter(s) (+ a or + a+b for instance), refer to the information below.

Benefits to be paid at the appropriate prevailing wage rate for the listed occupation.

If the “Benefits” section for the occupation lists only a dollar amount, disregard the information below.

Bricklayers, Cement Masons, Cement Finishers, Concrete Finishers, Stone Masons
(Building Construction) and
(Residential- Hartford, Middlesex, New Haven, New London and Tolland Counties)

- a. Paid Holiday: Employees shall receive 4 hours for Christmas Eve holiday provided the employee works the regularly scheduled day before and after the holiday. Employers may schedule work on Christmas Eve and employees shall receive pay for actual hours worked in addition to holiday pay.

Elevator Constructors: Mechanics

- a. Paid Holidays: New Year’s Day, Memorial Day, Independence Day, Labor Day, Veterans’ Day, Thanksgiving Day, Christmas Day, plus the Friday after Thanksgiving.
- b. Vacation: Employer contributes 8% of basic hourly rate for 5 years or more of service or 6% of basic hourly rate for 6 months to 5 years of service as vacation pay credit.

Glaziers

- a. Paid Holidays: Labor Day and Christmas Day.

Power Equipment Operators
(Heavy and Highway Construction & Building Construction)

- a. Paid Holidays: New Year’s Day, Good Friday, Memorial day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day, provided the employee works 3 days during the week in which the holiday falls, if scheduled, and if scheduled, the working day before and the working day after the holiday. Holidays falling on Saturday may be observed on Saturday, or if the employer so elects, on the preceding Friday.

Ironworkers

- a. Paid Holiday: Labor Day provided employee has been on the payroll for the 5 consecutive work days prior to Labor Day.

Laborers (Tunnel Construction)

- a. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day. No employee shall be eligible for holiday pay when he fails, without cause, to work the regular work day preceding the holiday or the regular work day following the holiday.

Roofers

- a. Paid Holidays: July 4th, Labor Day, and Christmas Day provided the employee is employed 15 days prior to the holiday.

Sprinkler Fitters

- a. Paid Holidays: Memorial Day, July 4th, Labor Day, Thanksgiving Day and Christmas Day, provided the employee has been in the employment of a contractor 20 working days prior to any such paid holiday.

Truck Drivers

(Heavy and Highway Construction & Building Construction)

- a. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Christmas day, and Good Friday, provided the employee has at least 31 calendar days of service and works the last scheduled day before and the first scheduled day after the holiday, unless excused.

Information Bulletin ***Occupational Classifications***

The Connecticut Department of Labor has the responsibility to properly determine "job classification" on prevailing wage projects covered under C.G.S. Section 31-53(d).

Note: This information is intended to provide a sample of some occupational classifications for guidance purposes only. It is not an all-inclusive list of each occupation's duties. This list is being provided only to highlight some areas where a contractor may be unclear regarding the proper classification. If unsure, the employer should seek guidelines for CTDOL.

Below are additional clarifications of specific job duties performed for certain classifications:

- **ASBESTOS WORKERS**

Applies all insulating materials, protective coverings, coatings and finishes to all types of mechanical systems.

- **ASBESTOS INSULATOR**

Handle, install apply, fabricate, distribute, prepare, alter, repair, dismantle, heat and frost insulation, including penetration and fire stopping work on all penetration fire stop systems.

- **BOILERMAKERS**

Erects hydro plants, incomplete vessels, steel stacks, storage tanks for water, fuel, etc. Builds incomplete boilers, repairs heat exchanges and steam generators.

- **BRICKLAYERS, CEMENT MASONS, CEMENT FINISHERS, MARBLE MASONS, PLASTERERS, STONE MASONS, PLASTERERS. STONE MASONS, TERRAZZO WORKERS, TILE SETTERS**

Lays building materials such as brick, structural tile and concrete cinder, glass, gypsum, terra cotta block. Cuts, tools and sets marble, sets stone, finishes concrete, applies decorative steel, aluminum and plastic tile, applies cements, sand, pigment and marble chips to floors, stairways, etc.

- **CARPENTERS, MILLWRIGHTS. PILEDRIVERMEN. LATHERS. RESILEINT FLOOR LAYERS, DOCK BUILDERS, DIKERS, DIVER TENDERS**

Constructs, erects, installs and repairs structures and fixtures of wood, plywood and wallboard. Installs, assembles, dismantles, moves industrial machinery. Drives piling into ground to provide foundations for structures such as buildings and bridges, retaining walls for earth embankments, such as cofferdams. Fastens wooden, metal or rockboard lath to walls, ceilings and partitions of buildings, acoustical tile layer, concrete form builder. Applies firestopping materials on fire resistive joint systems only. Installation of curtain/window walls only where attached to wood or metal studs. Installation of insulated material of all types whether blown, nailed or attached in other ways to walls, ceilings and floors of buildings. Assembly and installation of modular furniture/furniture systems. Free-standing furniture is not covered. This includes free standing: student chairs, study top desks, book box desks, computer furniture, dictionary stand, atlas stand, wood shelving, two-position information access station, file cabinets, storage cabinets, tables, etc.

- **LABORER, CLEANING**

- The clean up of any construction debris and the general (heavy/light) cleaning, including sweeping, wash down, mopping, wiping of the construction facility and its furniture, washing, polishing, and dusting.

- **DELIVERY PERSONNEL**

- If delivery of supplies/building materials is to one common point and stockpiled there, prevailing wages are not required. If the delivery personnel are involved in the distribution of the material to multiple locations within the construction site then they would have to be paid prevailing wages for the type of work performed: laborer, equipment operator, electrician, ironworker, plumber, etc.

- An example of this would be where delivery of drywall is made to a building and the delivery personnel distribute the drywall from one "stockpile" location to further sub-locations on each floor. Distribution of material around a construction site is the job of a laborer or tradesman, and not a delivery personnel.

- **ELECTRICIANS**

Install, erect, maintenance, alteration or repair of any wire, cable, conduit, etc., which generates, transforms, transmits or uses electrical energy for light, heat, power or other purposes, including the Installation or maintenance of telecommunication, LAN wiring or computer equipment, and low voltage wiring. ***License required per Connecticut General Statutes: E-1,2 L-5,6 C-5,6 T-1,2 L-1,2 V-1,2,7,8,9.**

- **ELEVATOR CONSTRUCTORS**

Install, erect, maintenance and repair of all types of elevators, escalators, dumb waiters and moving walks. **License required by Connecticut General Statutes: R-1,2,5,6.*

- **FORK LIFT OPERATOR**

Laborers Group 4) Mason Tenders - operates forklift solely to assist a mason to a maximum height of nine (9) feet only.

Power Equipment Operator Group 9 - operates forklift to assist any trade, and to assist a mason to a height over nine (9) feet.

- **GLAZIERS**

Glazing wood and metal sash, doors, partitions, and 2 story aluminum storefronts. Installs glass windows, skylights, store fronts and display cases or surfaces such as building fronts, interior walls, ceilings and table tops and metal store fronts. Installation of aluminum window walls and curtain walls is the "joint" work of glaziers and ironworkers, which require equal composite workforce.

- **IRONWORKERS**

Erection, installation and placement of structural steel, precast concrete, miscellaneous iron, ornamental iron, metal curtain wall, rigging and reinforcing steel. Handling, sorting, and installation of reinforcing steel (rebar). Metal bridge rail (traffic), metal bridge handrail, and decorative security fence installation. Installation of aluminum window walls and curtain walls is the "joint" work of glaziers and ironworkers which require equal composite workforce.

- **INSULATOR**

- Installing fire stopping systems/materials for "Penetration Firestop Systems": transit to cables, electrical conduits, insulated pipes, sprinkler pipe penetrations, ductwork behind radiation, electrical cable trays, fire rated pipe penetrations, natural polypropylene, HVAC ducts, plumbing bare metal, telephone and communication wires, and boiler room ceilings.

- **LABORERS**

Acetylene burners, asphalt rakers, chain saw operators, concrete and power buggy operator, concrete saw operator, fence and guard rail erector (except metal bridge rail (traffic), decorative security fence (non-metal)).

installation.), hand operated concrete vibrator operator, mason tenders, pipelayers (installation of storm drainage or sewage lines on the street only), pneumatic drill operator, pneumatic gas and electric drill operator, powermen and wagon drill operator, air track operator, block paver, curb setters, blasters, concrete spreaders.

- **PAINTERS**

Maintenance, preparation, cleaning, blasting (water and sand, etc.), painting or application of any protective coatings of every description on all bridges and appurtenances of highways, roadways, and railroads. Painting, decorating, hardwood finishing, paper hanging, sign writing, scenic art work and drywall hhg for any and all types of building and residential work.

- **LEAD PAINT REMOVAL**

- Painter's Rate

1. Removal of lead paint from bridges.
2. Removal of lead paint as preparation of any surface to be repainted.
3. Where removal is on a Demolition project prior to reconstruction.

- Laborer's Rate

1. Removal of lead paint from any surface NOT to be repainted.
2. Where removal is on a *TOTAL* Demolition project only.

- **PLUMBERS AND PIPEFITTERS**

Installation, repair, replacement, alteration or maintenance of all plumbing, heating, cooling and piping. ****License required per Connecticut General Statutes: P-1,2,6,7,8,9 J-1,2,3,4 SP-1,2 S-1,2,3,4,5,6,7,8 B-1,2,3,4 D-1,2,3,4.***

- **POWER EQUIPMENT OPERATORS**

Operates several types of power construction equipment such as compressors, pumps, hoists, derricks, cranes, shovels, tractors, scrapers or motor graders, etc. Repairs and maintains equipment. ****License required, crane operators only, per Connecticut General Statutes.***

- **ROOFERS**

Covers roofs with composition shingles or sheets, wood shingles, slate or asphalt and gravel to waterproof roofs, including preparation of surface. (demolition or removal of any type of roofing and or clean-up of any and all areas where a roof is to be relaid.)

- **SHEETMETAL WORKERS**

Fabricate, assembles, installs and repairs sheetmetal products and equipment in such areas as ventilation, air-conditioning, warm air heating, restaurant equipment, architectural sheet metal work, sheetmetal roofing, and aluminum gutters. Fabrication, handling, assembling, erecting, altering, repairing, etc. of coated metal material panels and composite metal material panels when used on building exteriors and interiors as soffits, fascia, louvers, partitions, canopies, cornice, column covers, awnings, beam covers, cladding, sun shades, lighting troughs, spires, ornamental roofing, metal ceilings, mansards, copings, ornamental and ventilation hoods, vertical and horizontal siding panels, trim, etc. The sheet metal classification also applies to the vast variety of coated metal material panels and composite metal material panels that have evolved over the years as an alternative to conventional ferrous and non-ferrous metals like steel, iron, tin, copper, brass, bronze, aluminum, etc. Fabrication, handling, assembling, erecting, altering, repairing, etc. of architectural metal roof, standing seam roof, composite metal roof, metal and composite bathroom/toilet partitions, aluminum gutters, metal and composite lockers and shelving, kitchen equipment, and walk-in coolers. To include testing and air –balancing ancillary to installation and construction.

- **SPRINKLER FITTERS**

Installation, alteration, maintenance and repair of fire protection sprinkler systems.

****License required per Connecticut General Statutes: F-1,2,3,4.***

- **TILE MARBLE AND TERRAZZO FINISHERS**

Assists and tends the tile setter, marble mason and terrazzo worker in the performance of their duties.

- **TRUCK DRIVERS**

~How to pay truck drivers delivering asphalt is under REVISION~

Truck Drivers are requires to be paid prevailing wage for time spent "working" directly on the site. These drivers remain covered by the prevailing wage for any time spent transporting between the actual construction location and facilities (such as fabrication, plants, mobile factories, batch plant, borrow pits, job headquarters, tool yards, etc.) dedicated exclusively, or nearly so, to performance of the contract or project, which are so located in proximity to the actual construction location that it is reasonable to include them. ****License required, drivers only, per Connecticut General Statutes.***

For example:

- Material men and deliverymen are not covered under prevailing wage as long as they are not directly involved in the construction process. If, they unload the material, they would then be covered by prevailing wage for the classification they are performing work in: laborer, equipment operator, etc.
- Hauling material off site is not covered provided they are not dumping it at a location outlined above.
- Driving a truck on site and moving equipment or materials on site would be considered covered work, as this is part of the construction process.

➤ *Any questions regarding the proper classification should be directed to:*
Public Contract Compliance Unit
Wage and Workplace Standards Division
Connecticut Department of Labor
200 Folly Brook Blvd, Wethersfield, CT 06109
(860) 263-6543.

Statute 31-55a

Last Updated: June 02, 2008

You are here: [DOL Web Site](#) ▶ [Wage and Workplace Issues](#) ▶ Statute 31-55a

- Special Notice -

To All State and Political Subdivisions, Their Agents, and Contractors

Connecticut General Statute 31-55a - Annual adjustments to wage rates by contractors doing state work.

Each contractor that is awarded a contract on or after October 1, 2002, for (1) the construction of a state highway or bridge that falls under the provisions of section 31-54 of the general statutes, or (2) the construction, remodeling, refinishing, refurbishing, rehabilitation, alteration or repair of any public works project that falls under the provisions of section 31-53 of the general statutes shall contact the Labor Commissioner on or before July first of each year, for the duration of such contract, to ascertain the prevailing rate of wages on an hourly basis and the amount of payment or contributions paid or payable on behalf of each mechanic, laborer or worker employed upon the work contracted to be done, and shall make any necessary adjustments to such prevailing rate of wages and such payment or contributions paid or payable on behalf of each such employee, effective each July first.

- The prevailing wage rates applicable to any contract or subcontract awarded on or after October 1, 2002 are subject to annual adjustments each July 1st for the duration of any project which was originally advertised for bids on or after October 1, 2002.
- Each contractor affected by the above requirement shall pay the annual adjusted prevailing wage rate that is in effect each July 1st, as posted by the Department of Labor.
- It is the *contractor's* responsibility to obtain the annual adjusted prevailing wage rate increases directly from the Department of Labor's Web Site. The annual adjustments will be posted on the Department of Labor Web page: www.ctdol.state.ct.us. For those without internet access, please contact the division listed below.
- The Department of Labor will continue to issue the initial prevailing wage rate schedule to the Contracting Agency for the project. All subsequent annual adjustments will be posted on our Web Site for contractor access.

Any questions should be directed to the Contract Compliance Unit, Wage and Workplace

Standards Division, Connecticut Department of Labor, 200 Folly Brook Blvd.,
Wethersfield, CT 06109 at (860)263-6790.

[Workplace Laws](#)

Published by the Connecticut Department of Labor, Project Management Office

November 29, 2006

Notice
To All Mason Contractors and Interested Parties
Regarding Construction Pursuant to Section 31-53 of the
Connecticut General Statutes (Prevailing Wage)

The Connecticut Labor Department Wage and Workplace Standards Division is empowered to enforce the prevailing wage rates on projects covered by the above referenced statute.

Over the past few years the Division has withheld enforcement of the rate in effect for workers who operate a forklift on a prevailing wage rate project due to a potential jurisdictional dispute.

The rate listed in the schedules and in our Occupational Bulletin (see enclosed) has been as follows:

Forklift Operator:

- **Laborers (Group 4) Mason Tenders** - operates forklift solely to assist a mason to a maximum height of nine feet only.
- **Power Equipment Operator (Group 9)** - operates forklift to assist any trade and to assist a mason to a height over nine feet.

The U.S. Labor Department conducted a survey of rates in Connecticut but it has not been published and the rate in effect remains as outlined in the above Occupational Bulletin.

Since this is a classification matter and not one of jurisdiction, effective January 1, 2007 the Connecticut Labor Department will enforce the rate on each schedule in accordance with our statutory authority.

Your cooperation in filing appropriate and accurate certified payrolls is appreciated.

Informational Bulletin

THE 10-HOUR OSHA CONSTRUCTION SAFETY AND HEALTH COURSE

(applicable to public building contracts entered into *on or after July 1, 2007*, where the total cost of all work to be performed is at least \$100,000)

- (1) This requirement was created by Public Act No. 06-175, which is codified in Section 31-53b of the Connecticut General Statutes (pertaining to the prevailing wage statutes);
- (2) The course is required for public building construction contracts (projects funded in whole or in part by the state or any political subdivision of the state) entered into on or after July 1, 2007;
- (3) It is required of private employees (not state or municipal employees) and apprentices who perform manual labor for a general contractor or subcontractor on a public building project where the total cost of all work to be performed is at least \$100,000;
- (4) The ten-hour construction course pertains to the ten-hour Outreach Course conducted in accordance with federal OSHA Training Institute standards, and, for telecommunications workers, a ten-hour training course conducted in accordance with federal OSHA standard, 29 CFR 1910.268;
- (5) The internet website for the federal OSHA Training Institute is http://www.osha.gov/fso/ote/training/edcenters/fact_sheet.html;
- (6) The statutory language leaves it to the contractor and its employees to determine who pays for the cost of the ten-hour Outreach Course;
- (7) Within 30 days of receiving a contract award, a general contractor must furnish proof to the Labor Commissioner that all employees and apprentices performing manual labor on the project will have completed such a course;
- (8) Proof of completion may be demonstrated through either: (a) the presentation of a *bona fide* student course completion card issued by the federal OSHA Training Institute; *or* (2) the presentation of documentation provided to an employee by a trainer certified by the Institute pending the actual issuance of the completion card;
- (9) Any card with an issuance date more than 5 years prior to the commencement date of the construction project shall not constitute proof of compliance;

- (10) Each employer shall affix a copy of the construction safety course completion card to the certified payroll submitted to the contracting agency in accordance with Conn. Gen. Stat. § 31-53(f) on which such employee's name first appears;
- (11) Any employee found to be in non-compliance shall be subject to removal from the worksite if such employee does not provide satisfactory proof of course completion to the Labor Commissioner by the fifteenth day after the date the employee is determined to be in noncompliance;
- (12) Any such employee who is determined to be in noncompliance may continue to work on a public building construction project for a maximum of fourteen consecutive calendar days while bringing his or her status into compliance;
- (13) The Labor Commissioner may make complaint to the prosecuting authorities regarding any employer or agent of the employer, or officer or agent of the corporation who files a false certified payroll with respect to the status of an employee who is performing manual labor on a public building construction project;
- (14) The statute provides the minimum standards required for the completion of a safety course by manual laborers on public construction contracts; any contractor can exceed these minimum requirements; and
- (15) Regulations clarifying the statute are currently in the regulatory process, and shall be posted on the CTDOL website as soon as they are adopted in final form.
- (16) Any questions regarding this statute may be directed to the Wage and Workplace Standards Division of the Connecticut Labor Department via the internet website of <http://www.ctdol.state.ct.us/wgwkstnd/wgemenu.htm>; or by telephone at (860)263-6790.

THE ABOVE INFORMATION IS PROVIDED EXCLUSIVELY AS AN EDUCATIONAL RESOURCE, AND IS NOT INTENDED AS A SUBSTITUTE FOR LEGAL INTERPRETATIONS WHICH MAY ULTIMATELY ARISE CONCERNING THE CONSTRUCTION OF THE STATUTE OR THE REGULATIONS.

Sec. 31-53b. Construction safety and health course. Proof of completion required for employees on public building projects. Enforcement. Regulations. (a) Each contract entered into on or after July 1, 2007, for the construction, remodeling, refinishing, refurbishing, rehabilitation, alteration or repair of any public building project by the state or any of its agents, or by an political subdivision of the state or any of its agents, where the total cost of all work to be performed by all contractors and subcontractors in connection with the contract is at least one hundred thousand dollars, shall contain a provision requiring that, not later than thirty days after the date such contract is awarded, each contractor furnish proof to the Labor Commissioner that all employees performing manual labor on or in such public building, pursuant to such contract, have completed a course of at least ten hours in duration in construction safety and health approved by the federal Occupational Safety and Health Administration or, in the case of telecommunications employees, have completed at least ten hours of training in accordance with 29 CFR 1910.268.

(b) Any employee required to complete a construction safety and health course required under subsection (a) of this section who has not completed the course shall be subject to removal from the worksite if the employee does not provide documentation of having completed such course by the fifteenth day after the date the employee is found to be in noncompliance. The Labor Commissioner or said commissioner's designee shall enforce this section.

(c) Not later than January 1, 2007, the Labor Commissioner shall adopt regulations, in accordance with the provisions of chapter 54, to implement the provisions of subsections (a) and (b) of this section. Such regulations shall require that the ten-hour construction safety and health courses required under subsection (a) of this section be conducted in accordance with federal Occupational Safety and Health Administration Training Institute standards, or in accordance with 29 CFR 1910.268, as appropriate. The Labor Commissioner shall accept as sufficient proof of compliance with the provisions of subsection (a) or (b) of this section a student course completion card issued by the federal Occupational Safety and Health Administration Training Institute, or such other proof of compliance said commissioner deems appropriate, dated no earlier than five years before the commencement date of such public works project.

(d) For the purposes of this section, "public building" means a structure, paid for in whole or in part with state funds, within a roof and within exterior walls or fire walls, designed for the housing, shelter, enclosure and support or employment of people, animals or property of any kind, including, but not limited to, sewage treatment plants and water treatment plants, "Public building" does not include site work, roads or bridges, rail lines, parking lots or underground water, sewer or drainage systems including pump houses or other utility systems.

CONNECTICUT DEPARTMENT OF LABOR
WAGE AND WORKPLACE STANDARDS DIVISION

CONTRACTORS WAGE CERTIFICATION FORM

I, _____ of _____
Officer, Owner, Authorized Rep. Company Name

do hereby certify that the _____
Company Name

Street

City

and all of its subcontractors will pay all workers on the

Project Name and Number

Street and City

the wages as listed in the schedule of prevailing rates required for such project (a copy of which is attached hereto).

Signed

Subscribed and sworn to before me this _____ day of _____, 2004.

Notary Public

 Return to:

Connecticut Department of Labor
Wage & Workplace Standards Division
200 Folly Brook Blvd.
Wethersfield, CT 06109