

MAINE TURNPIKE AUTHORITY

MAINE TURNPIKE

CONTRACT DOCUMENTS

CONTRACT 2026.20

MTA HEADQUARTERS BUILDING IMPROVEMENTS PROJECT
C-SUITE, NURSING ROOM, AND OFFICES

NOTICE TO CONTRACTORS

PROPOSAL

CONTRACT AGREEMENT

CONTRACT BOND

FINAL LIEN AND CLAIM WAIVER AND AFFIDAVIT

SPECIFICATIONS

MAINE TURNPIKE AUTHORITY
SPECIFICATIONS

The Specifications are divided into two parts:
Part I, Supplemental Specifications and Part II, Special
Provisions.

The Maine Turnpike Supplemental Specifications are additions
and alterations to the 2014 Maine Department of
Transportation Standard Specifications. See Subsection 100.1.

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MAINE TURNPIKE AUTHORITY

NOTICE TO CONTRACTORS

Sealed Proposals will be received by the Maine Turnpike Authority for:

CONTRACT 2026.20

MTA HEADQUARTERS BUILDING IMPROVEMENTS PROJECT
C-SUITE, NURSING ROOM, AND OFFICES

at the office of the Maine Turnpike Authority, 2360 Congress Street, Portland, ME, until 11:00 a.m., prevailing time as determined by the Authority on March 10, 2026 at which time and place the Proposals will be publicly opened and read. Bids will be accepted from Contractors **prequalified** by the Maine Department of Transportation for Building Construction Projects. All other bids may be rejected. This Project includes a wage determination developed by the State of Maine Department of Labor.

The work consists of improvements to the Maine Turnpike Headquarters Building located at 2360 Congress Street, Portland Maine. The work includes selective demolition and construction of a new nursing suite, offices, and conference rooms. Work also includes modifications to the mechanical, electrical, fire suppression, fire alarm, and plumbing systems to support the upgrades as well as all other work incidental thereto in accordance with the Plans and Specifications.

The half size Plans and Contract Documents may be obtained from the Authority upon payment of One Hundred (\$100.00) Dollars for each set, which payment will not be returned. Checks shall be made payable to: Maine Turnpike Authority. The Plans and Contract Documents may also be downloaded from a link on our website at <http://www.maineturnpike.com/project-and-planning/Construction-Contracts.aspx>.

For general information regarding Bidding and Contracting procedures, contact Nate Carll, Purchasing Manager, at (207) 482-8115. For information regarding Schedule of Items, plan holders list and bid results, visit our website at <http://www.maineturnpike.com/project-and-planning/Construction-Contracts.aspx>. To submit questions, use the electronic Request For Information (RFI) tab at <https://www.maineturnpike.com/projects/construction-contracts> for Contract 2026.20. Responses will not be prepared for questions received by telephone. Bidders shall not contact any other Authority staff or Consultants for clarification of Contract provisions, and the Authority will not be responsible for any interpretations so obtained.

All work shall be governed by the Specifications entitled "State of Maine, Department of Transportation, Standard Specifications, Revision of November 2014", "Standard Details, Revision of November 2014" and "Best Management Practices for Erosion and Sediment Control", latest issue. Copies and recent updates to these publications can be downloaded at: <http://www.maine.gov/mdot/contractors/publications/>.

Proposals must be accompanied by an original bid bond, certified or cashier's check payable to the Maine Turnpike Authority in an amount not less than Five (5%) Percent of the Total Amount in the Proposal, but not less than \$500.00. The Bidder to whom a Contract is awarded will be required to furnish a Surety Corporation Bond, satisfactory to the Authority, on the standard Contract Bond form of the Authority, for a sum not less than the Total Amount of the Proposal.

Proposals must be made upon the Proposal Forms furnished by the Authority separately with the Contract Documents, and must be enclosed in the sealed special addressed envelope provided therefore bearing the name and address of the Bidder, the name of the Contract, and the date and time of Proposal opening on the outside.

A pre-bid conference will be held on February 20, 2026 at 10:00 a.m. at the Maine Turnpike Authority, 2360 Congress Street, Portland, Maine.

The Authority reserves the unqualified right to reject any or all Proposals and to accept that Proposal which in its sole judgment will under all circumstances serve its best interest.

MAINE TURNPIKE AUTHORITY

Nate Carll
Purchasing Manager
Maine Turnpike Authority

Portland, Maine

Maine Turnpike Authority

MAINE TURNPIKE

PROPOSAL

CONTRACT 2026.20

MTA HEADUARTERS BUILDING IMPROVEMENTS PROJECT
C-SUITE, NURSING ROOM, AND OFFICES

MAINE TURNPIKE AUTHORITY

PROPOSAL

CONTRACT 2026.20

MTA HEADQUARTERS BUILDING IMPROVEMENTS PROJECT
C-SUITE, NURSING ROOM, AND OFFICES

TO MAINE TURNPIKE AUTHORITY:

The work consists of improvements to the Maine Turnpike Headquarters Building located at 2360 Congress Street, Portland Maine. The work includes selective demolition and construction of a new nursing suite, offices, and conference rooms. Work also includes modifications to the mechanical, electrical, fire suppression, fire alarm, and plumbing systems to support the upgrades as well as all other work incidental thereto in accordance with the Plans and Specifications.

This Work will be done under a Contract known as Contract 2026.20 according to the Plans and Specifications which are on file in the office of the Maine Turnpike Authority, 2360 Congress Street, Portland, Maine.

On the acceptance of this Proposal for said Work, the undersigned will give the required bond with good security conditioned for the faithful performance of said Work, according to said Plans and Specifications, and the doing of all other work required by said Specifications for the consideration herein named and with the further condition that the Maine Turnpike Authority shall be saved harmless from any and all damages that might accrue to any person, persons or property by reason of the carrying out of said Work, or any part thereof, or by reason of negligence of the undersigned, or any person or persons under his employment and engaged in said Work.

The undersigned hereby declares that he/she has carefully examined the Plans, Specifications and other Contract Documents, and that he/she will contract to carry out and complete the said Work as specified and delineated at the price per unit of measure for each scheduled item of Work stated in the Schedule of Prices as follows:

It is understood that the TOTAL AMOUNT stated by the undersigned in the following Schedule of Prices is based on approximate quantities and will be used solely for the comparison of bids, and that the quantities stated in the Schedule of Prices for the various items are estimates only and may be increased or decreased all as provided in the Specifications.

SCHEDULE OF BID PRICES
CONTRACT NO. 2026.20
MTA HEADQUARTERS
BUILDING IMPROVEMENTS PROJECT
C-SUITE, NURSING ROOM, AND OFFICES

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
631.53	ELECTRICIAN	Hour	20				
631.54	ELECTRICIAN'S APPRENTICE	Hour	20				
631.55	PLUMBER	Hour	16				
631.56	PLUMBER'S APPRENTICE	Hour	16				
631.57	HVAC TECHNICIAN	Hour	16				
631.58	HVAC APPRENTICE	Hour	16				
659.10	MOBILIZATION	Lump Sum	1				
800.01	MAINE TURNPIKE HEADQUARTERS BUILDING RENOVATION	Lump Sum	1				
TOTAL:							

Acknowledgment is hereby made of the following Addenda received since issuance of the Plans and Specifications: _____

Accompanying this Proposal is an original bid bond, cashiers or certified check on _____ Bank, for _____, payable to the Maine Turnpike Authority. In case this Proposal shall be accepted by the Maine Turnpike Authority and the undersigned should fail to execute a Contract with, and furnish the security required by the Maine Turnpike Authority as set forth in the Specifications, within the time fixed therein, an amount of money equal to Five (5%) Percent of the Total Amount of the Proposal for the Contract awarded to the undersigned, but not less than \$500.00, obtained out of the original bid bond, cashier's or certified check, shall become the property of the Maine Turnpike Authority; otherwise the check will be returned to the undersigned.

The performance of said Work under this Contract will be completed during the time specified in Subsection 107.1.

It is agreed that time is of the essence of this Contract and that I (we) will, in the event of my (our) failure to complete the Work within the time limit named above, pay to Maine Turnpike Authority liquidated damages in the amount or amounts stated in the Specifications.

The undersigned is an Individual/Partnership/Corporation under the laws of the State of _____, having principal office at _____, thereunto duly authorized.

_____ (*SEAL*)

_____ (*SEAL*)

*Affix Corporate Seal
or Power of Attorney
Where Applicable*

_____ (*SEAL*)

By: _____

Its: _____

Information below to be typed or printed where applicable:

INDIVIDUAL:

(Name)

(Address)

PARTNERSHIP - Name and Address of General Partners:

(Name)

(Address)

(Name)

(Address)

(Name)

(Address)

(Name)

(Address)

INCORPORATED COMPANY:

(President)

(Address)

(Vice-President)

(Address)

(Secretary)

(Address)

(Treasurer)

(Address)

MAINE TURNPIKE AUTHORITY

MAINE TURNPIKE

YORK TO AUGUSTA

CONTRACT AGREEMENT

This Agreement made and entered into between the Maine Turnpike Authority, and sometimes termed the "Authority", and _____

herein termed the "Contractor":

WITNESSETH: That the Authority and the Contractor, in consideration of the premises and of the mutual covenants, considerations and agreements herein contained, agree as follows:

FIRST: The parties hereto mutually agree that the documents attached hereto and herein incorporated and made a part hereof collectively evidencing and constituting the entire Contract to the same extent as if herein written in full, are the Notice to Contractors, the Accepted Proposal, the Specifications, the Plans, this Agreement, the Contract Bond and all Addenda to the Contract Documents duly issued and herewith enumerated:

SECOND: The Contractor for and in consideration of certain payments to be made as hereafter specified, hereby covenants and agrees to perform and execute all of the provisions of this Contract and of all documents and parts attached hereto and made a part thereof, and at his own cost and expense to furnish and perform everything necessary and required to construct and complete, ready for its intended purpose, in accordance with the Contract and such instructions as the Engineer may give, acceptable to the Authority, in the times provided, all of the Work covered and included under Contract No. _____ covering _____ as herein described.

THIRD: In consideration of the performance by the Contractor of his covenants and agreements as herein set forth, the Authority hereby covenants and agrees to pay the Contractor according to the Schedule of Prices set forth in the Proposal with additions and deductions as elsewhere herein provided in the times and in the manner stated in the Specifications. This Agreement shall insure to the benefit of, and shall be binding upon the parties hereto, and upon their respective successors and assigns; but neither party hereto shall assign or transfer his interest herein in whole or in part without the consent of the other, except as herein provided.

IN WITNESS WHEREOF the parties to this Agreement have executed the same in quintuplicate.

AUTHORITY -

MAINE TURNPIKE AUTHORITY

By: _____

Title: CHAIRMAN

Date of Signature: _____

ATTEST:

Secretary

CONTRACTOR -

CONTRACTOR

By: _____

Title: _____

Date of Signature: _____

WITNESS:

CONTRACT BOND

KNOW ALL MEN BY THESE PRESENTS that _____
 of _____ in the County of _____ and State of _____
 as Principal, and _____ a Corporation duly organized under the
 laws of the State of _____ and having a usual place of business in _____

As Surety, are held and firmly bound unto the Maine Turnpike Authority in the sum of _____ Dollars (\$_____._____), to be paid to said Maine Turnpike Authority, or its successors, for which payment, well and truly to be made, we bind ourselves, our heirs, executors, successors and assigns jointly and severally by these presents.

The condition of this obligation is such that the Principal, designated as Contractor in the foregoing Contract No. _____ shall faithfully perform the Contract on his part and satisfy all claims and demands incurred for the same and shall pay all bills for labor, material, equipment and all other items contracted for, or used by him, in connection with the Work contemplated by said Contract, and shall fully reimburse the Obligee for all outlay and expense which the Obligee may incur in making good any default of said Principal, then this Obligation shall be null and void; otherwise it shall remain in full force and effect.

Signed and sealed this _____ day of _____, A.D., 201____

Witnesses:

CONTRACTOR

_____ (SEAL)

_____ (SEAL)

_____ (SEAL)

SURETY

_____ (SEAL)

_____ (SEAL)

_____ (SEAL)

(Surety must attach copy of Power of Attorney showing authority of Office or Agent to execute bonds)

FINAL LIEN AND CLAIM WAIVER AND AFFIDAVIT

Upon receipt of the sum of _____, which sum represents the total amount paid, including the current payment for work done and materials supplied for Project No. _____, in _____, Maine, under the undersigned's Contract with the Maine Turnpike Authority.

The undersigned, on oath, states that the Final Payment of _____ is the final payment for all work, labor, materials, services and miscellaneous (all of which are hereinafter referred to as "Work Items") supplied to the said Project through _____ and that no additional sum is claimed by the undersigned respecting said Project.

The undersigned, on oath, states that all persons and firms who supplied Work Items to the undersigned in connection with said Project have been fully paid by the undersigned for such Work Items or that such payment will be fully effected immediately upon receipt of this payment.

In consideration of the payment herewith made, the undersigned does fully and finally release and hold harmless the Maine Turnpike Authority, and its Surety, if any, from any and all claims, liens or right to claim or lien, arising out of this Project under any applicable bond, law or statute.

It is understood that this Affidavit is submitted to assure the Owner and others that all liens and claims relating to the Work Items furnished by the undersigned are paid.

(Contractor)

By: _____

Title: _____

State of MAINE

County of _____

I, _____, hereby certify on behalf of _____
(*Company Officer*) (Company Name)
its _____, being first duly sworn and stated that the foregoing representations are
(*Title*)
are true and correct upon his own knowledge and that the foregoing is his free act and deed in said capacity
and the free act and deed of the above-named

(*Company Name*)

The above-named, _____, personally appeared before me this _____ day of
_____ and swears that this is his free act and deed.

(*SEAL*)

Notary Public

My Commission Expires: _____

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART I – SUPPLEMENTAL SPECIFICATIONS

(Rev. November 10, 2016)

The Supplemental Specifications are not included in these contract documents but are available at
<https://www.maineturnpike.com/Projects/Construction-Related-Documents.aspx> for download.

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART II – SPECIAL PROVISIONS

PART II - SPECIAL PROVISIONS

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NOT USED

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NOT USED

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DIVISION 6 – WOOD, PLASTIC AND COMPOSITES

SECTION 061053 – MISCELLANEOUS ROUGH CARPENTRY

SECTION 062023 – INTERIOR FINISH CARPENTRY

SECTION 064116 – PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

SECTION 064600 – ARCHITECTURAL WOODWORK

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

SECTION 078413 – PENETRATION FIRESTOPPING

SECTION 079200 – JOINT SEALANTS

SECTION 079219 – ACOUSTICAL JOINT SEALANTS

DIVISION 8 – OPENINGS

SECTION 081213 – HOLLOW METAL FRAMES

SECTION 081416 – FLUSH WOOD DOORS

SECTION 087100 – DOOR HARDWARE

SECTION 088000 – GLAZING

SECTION 088813 – FIRE-RESISTANT GLAZING

DIVISION 9 – FINISHES

SECTION 092216 – NON-STRUCTURAL METAL FRAMING

SECTION 092900 – GYPSUM BOARD

SECTION 095123 – ACOUSTIC TILE CEILINGS

SECTION 096513 – RESILIENT BASE AND ACCESSORIES

SECTION 096810 – CARPET TILE

SECTION 099123 – INTERIOR PAINTING

SECTION 099300 – STAINING AND TRANSPARENT FINISHING

DIVISION 10 – SPECIALTIES

NOT USED

DIVISION 11 – EQUIPMENT

SECTION 113100 – RESIDENTIAL APPLIANCES

DIVISION 12 – FURNISHINGS

SECTION 123661.16 – SOLID SURFACING COUNTERTOPS

DIVISION 13 – SPECIAL CONSTRUCTION

NOT USED

DIVISION 14 – CONVEYING SYSTEMS

NOT USED

DIVISION 22 - PLUMBING

- 220700 PLUMBING INSULATION
- 220800 COMMISSIONING OF PLUMBING
- 221116 DOMESTIC WATER PIPING
- 221316 PLUMBING SANITARY AND STORM PIPING
- 224000 PLUMBING FIXTURES

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

- 230500 COMMON WORK RESULTS FOR MECHANICAL
- 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC
- 230700 MECHANICAL INSULATION
- 230800 COMMISSIONING OF HVAC
- 230900 INSTRUMENTATION AND CONTROL FOR HVAC (NIC – ISSUED FOR REFERENCE AND COORDINATION ONLY)
- 230993 SEQUENCE OF OPERATIONS
- 232113 HYDRONIC HVAC PIPING
- 233113 DUCTWORK
- 233600 AIR TERMINALS UNITS
- 233713 DIFFUSERS, REGISTERS, AND GRILLES

DIVISION 26 – ELECTRICAL

- 260519 LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
- 260533.13 CONDUITS FOR ELECTRICAL SYSTEMS
- 260533.16 BOXES AND COVERS FOR ELECTRICAL SYSTEMS
- 260923 LIGHTING CONTROL DEVICES
- 262726.33 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES
- 262726.37 RECEPTACLES WITH GROUND-FAULT PROTECTIVE DEVICES
- 265119 LED INTERIOR LIGHTING

DIVISION 27 – COMMUNICATIONS

- 270528 PATHWAYS FOR COMMUNICATIONS SYSTEMS
- 270553 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS
- 271513 COMMUNICATIONS COPPER HORIZONTAL CABLING

MAINE TURNPIKE AUTHORITYSPECIFICATIONSPART II - SPECIAL PROVISIONS

All work shall be governed by the Maine Department of Transportation Standard Specifications, Revision of November 2014, except for that work which applies to sections of the Maine Department of Transportation Standard Specifications which are amended by the Maine Turnpike Supplemental Specifications and the following modifications, additions and deletions.

General Description of Work

The work consists of improvements to the Maine Turnpike Headquarters Building located at 2360 Congress Street, Portland Maine. The work includes selective demolition and construction of a new nursing suite, offices, and conference rooms. Work also includes modifications to the mechanical, electrical, fire suppression, fire alarm, and plumbing systems to support the upgrades as well as all other work incidental thereto in accordance with the Plans and Specifications. The work generally includes, but is not limited to:

1. Architectural
 - a. Select demolition to support reconfigured offices and conference rooms
 - b. Installation of new nursing suite including new cabinets, hardware, and countertop
 - c. Select interior painting and flooring replacement
 - d. Select interior door and window install/replacement
 - e. Select acoustical ceiling demo and replacement
2. Mechanical/Plumbing/HVAC
 - a. Modify mechanical, plumbing, and HVAC infrastructure to accommodate reconfigured offices and conference rooms.
 - b. Modify and upsize duct work to support improved ventilation
 - c. Install new Variable Air Volume (VAV) Boxes to support reconfigure offices and conference rooms
 - d. Coordinate with XL Automation for control of new and reconfigured systems
 - e. Re-balance affected office spaces
3. Electrical
 - a. Modify electrical, fire alarm, and communications infrastructure to accommodate reconfigured offices and conference rooms.
4. Fire Protection:
 - a. Modify existing sprinkler system infrastructure to accommodate reconfigured offices and conference rooms.

Plans

The drawings included in these Contract Documents, and referred to as the Plans, show the general character of the work to be done under this Contract. They bear the general title "Maine

Turnpike – Contract 2026.20 – MTA Headquarters Building Improvements Project - C-Suite, Nursing Room, and Offices". The right is reserved by the Resident to make such minor corrections or alterations in the Plans as he deems necessary without change in the unit prices on the Schedule of Prices of the Proposal.

101.2 Definition

Maine Turnpike Normal Business Hours: Typical hours of operation for Maine Turnpike staff is 8:00 a.m. to 5:00 p.m., Monday through Friday. The Communications Center is staffed 24 hours a day, every day.

State Police Normal Business Hours: Typical hours of operation for the State Police Offices is 8:00 a.m. to 4:00 p.m., Monday through Friday.

102.6 Bid Guaranty

Replace the last paragraph with the following:

Bid Bonds must be: (A) issued by an insurance company licensed or approved by the State of Maine, Department of Business Regulation, Bureau of Insurance, to do business in the State of Maine; and (B) properly signed by the bidder (as Principal) and a duly authorized representative of the insurance company referenced above.

103.4 Notice of Award

The following sentence is added:

The Maine Turnpike Authority Board is scheduled to consider the Contract Award on March 26, 2026.

104.2.2 Furnishing of Permits

The Maine Turnpike Authority will obtain and provide the building permit and State Fire Marshal's construction permit, if required.

The Contractor shall obtain the following permits: Local or State Electrical, Plumbing, HVAC Systems, Sprinkler, and/or Fire Alarm as required by the Authority Having Jurisdiction.

104.3.8 Wage Rates and Labor Laws

Section 104.3.8 Wage Rates and Labor Laws has been amended as follows:

The fair minimum hourly rates determined by the State of Maine Department of Labor for this Contract are as follows:

State of Maine
 Department of Labor
 Bureau of Labor Standards
 Augusta, Maine 04333-0045
 Telephone (207) 623-7906

Wage Determination - In accordance with 26 MRS §1301 et. seq., this is a determination by the Bureau of Labor Standards, of the fair minimum wage rate to be paid to laborers and workers employed on the below titled project.

2026 Fair Minimum Wage Rates – Building 2 Cumberland County (other than 1 or 2 family homes)

<u>Occupational Title</u>	<u>Minimum Wage</u>	<u>Minimum Benefit</u>	<u>Total</u>
Brickmasons and Blockmasons	\$43.91	\$11.02	\$54.93
Bulldozer Operator	\$30.62	\$5.38	\$36.00
Carpenter	\$30.01	\$19.69	\$49.70
Cement Masons and Concrete Finisher	\$45.38	\$34.84	\$80.22
Construction and Maintenance Painters	\$26.23	\$2.81	\$29.04
Construction Laborer	\$21.90	\$19.72	\$41.62
Conveyor Operators and Tenders	\$30.17	\$13.77	\$43.94
Crane and Tower Operators	\$40.43	\$8.63	\$49.06
Crushing Grinding and Polishing Machine Operators	\$26.15	\$3.24	\$29.39
Earth Drillers - Except Oil and Gas	\$25.04	\$3.77	\$28.81
Electrical Power - Line Installer and Repairers	\$48.12	\$15.63	\$63.75
Electricians	\$38.75	\$21.52	\$60.27
Elevator Installers and Repairers	\$72.19	\$44.52	\$116.71
Excavator Operator	\$31.75	\$5.53	\$37.28
Fence Erectors	\$26.69	\$3.29	\$29.98
Flaggers	\$21.39	\$0.86	\$22.25
Floor Layers - Except Carpet/Wood/Hard Tiles	\$29.00	\$8.65	\$37.65
Glaziers	\$39.32	\$19.22	\$58.54
Hazardous Materials Removal Workers	\$25.01	\$2.04	\$27.05
Heating and Air Conditioning and Refrigeration Mechanics and Installers	\$36.11	\$6.39	\$42.50
Heavy and Tractor - Trailer Truck Drivers	\$26.10	\$4.07	\$30.17
Highway Maintenance Workers	\$23.30	\$1.14	\$24.44
Industrial Machinery Mechanics	\$29.97	\$6.74	\$36.71
Industrial Truck and Tractor Operators	\$24.61	\$4.21	\$28.82
Insulation Worker - Mechanical	\$28.57	\$17.06	\$45.63
Light Truck or Delivery Services Drivers	\$26.79	\$5.14	\$31.93
Loading Machine and Dragline Operators	\$26.99	\$5.12	\$32.11
Millwrights	\$35.99	\$10.52	\$46.51
Mobile Heavy Equipment Mechanics - Except Engines	\$26.43	\$5.48	\$31.91
Operating Engineers and Other Equipment Operators	\$47.25	\$31.30	\$78.55
Paving Surfacing and Tamping Equipment Operators	\$30.74	\$10.67	\$41.41
Pile-Driver Operators	\$37.15	\$3.12	\$40.27
Pipe/Steam/Sprinkler Fitter	\$43.76	\$25.44	\$69.20
Pipeliners	\$28.75	\$3.64	\$32.39
Plumbers	\$40.00	\$24.71	\$64.71
Radio Cellular and Tower Equipment Installers	\$34.72	\$5.63	\$40.35
Reinforcing Iron and Rebar Workers	\$48.19	\$1.93	\$50.12
Riggers	\$32.94	\$25.00	\$57.94
Roofers	\$28.42	\$4.56	\$32.98
Sheet Metal Workers	\$30.18	\$6.64	\$36.82
Structural Iron and Steel Workers	\$27.16	\$21.25	\$48.41
Tapers	\$31.43	\$5.47	\$36.90
Telecommunications Equipment Installers and Repairers - Except Line Installers	\$32.28	\$14.53	\$46.81
Telecommunications Line Installers and Repairers	\$34.84	\$17.48	\$52.32
Tile and Marble Setters	\$28.91	\$5.46	\$34.37

Welders are classified as the trade to which welding is incidental (e.g. welding structural steel is Structural Iron and Steel Worker)

Apprentices – The minimum wage rates for registered apprentices are the rates recognized in the sponsorship agreement for registered apprentices working in the pertinent classification.

For any other specific trade on this project not listed above, contact the Bureau of Labor Standards for further clarification.

Title 26 §1310 requires that a clearly legible statement of all fair minimum wage and benefits rates to be paid the several classes of laborers, workers and mechanics employed on the construction on the public work must be kept posted in a prominent and easily accessible place at the site by each contractor and subcontractor subject to sections 1304 to 1313.

Appeal – Any person affected by the determination of these rates may appeal to the Commissioner of Labor by filing a written notice with the Commissioner stating the specific grounds of the objection within ten (10) days from the filing of these rates.

A true copy

Attest: Scott R. Cotnoir
 Scott R. Cotnoir
 Wage & Hour Director
 Bureau of Labor Standards

Supersedes 02-03-2025
 Effective 01-10-2026

104.4.6.1 Temporary Utilities

The contractor will be required to maintain access and all services and utilities to owner occupied areas of the building throughout construction. Existing services and utilities include but are not necessarily limited to: permanent and backup power, telephone, internet, water, sewer, propane, heat, cooling and site/roadway lighting.

The Contractor shall be responsible for the cost of any temporary connections, service runs, relocations, disconnections, reconnections, etc. required to maintain these services due to phasing of construction and constraints of the site and work area.

Prior to the start of each construction phase, the Contractor shall submit a plan and schedule for maintaining existing services and utilities. The plan shall identify all proposed temporary connections, service runs, relocations, disconnections, reconnections, etc. and shall reflect construction phasing and the Contractor's proposed sequence of work. Maintaining utility services, including all temporary utility work required, shall be incidental to the contract.

104.4.7 Cooperation With Other Contractors

This Subsection is amended by the addition of the following:

Adjacent contracts currently scheduled for the 2026 construction season include:

MTA Contract 2026.09: York/Portland: Mile 10 Maintenance, MTA Headquarters Parking Lot and Park & Ride Parking Lot Pavement Rehabilitation.

The Contractor of Contract 2026.20 shall be aware, depending on schedule of project 2026.09, they may be required to relocate their stored materials and contractor parking to allow paving to proceed within 3 days of notice. Building entrances and exits may also be restricted as paving proceeds around the building. Once pavement has been placed in an area, the Contractor of 2026.20 shall take all necessary measures to protect the new pavement from damage caused by equipment or materials, including but not limited to dumpsters and Connex boxes. Damaged pavement will be required to be removed and replaced at the expense of Contractor for Contract 2026.20.

105.11 As-Built Plans

The Contractor shall provide the Authority with as-built plans in PDF and MicroStation or AutoCAD. The as-built plans shall note changes to the bid documents, including, but not limited to pavement, concrete, barrier, guardrail, culverts, drainage, foundations, wiring, signs, etc. The as-builts plans shall also provide GPS accurate locations of all underground work. Submittal of Draft, Final Draft, and 100% as-built plans to the Resident shall be conditions of Mobilization Payment, Retainage Reduction, and Final Payment as noted in Special Provision 108.

105.11.1 As-Built Plan Submittals

The Contractor shall make the following submittals of as-built plans to the Resident as part of the conditions of Mobilization Payment, Retainage Reduction, and Final Payment as noted in Special Provision 108:

- a. Draft As-built Plans containing any underground work completed within the prior 30 day period once 50% of the Work is complete.
- b. Final Draft As-Built Plans containing all underground work
- c. 100% As-Built Plans containing all underground work and changes

105.11.2 As Built Plan Requirements

As-built plans and CADD files shall conform to the following requirements:

- a. Include legend of line weights and styles
- b. Project stationing shall be on its own layer and be color white
- c. Changes to pavement, concrete, barrier, guardrail, foundations, signs etc. shall be on their own layer and be color brown
- d. Electric power lines, cable, conduit, and lighting cables shall be on their own layer and be color red
- e. Gas, oil, steam, petroleum, or gaseous materials shall be on their own layer and be color yellow
- f. Communication, alarm or signal lines, cables, or conduit shall be on their own level and be color orange
- g. Potable water shall be on its own layer and be color blue
- h. Sewers and drain lines shall be on their own layer and be color green
- i. Reclaimed water, irrigation, and slurry lines shall be on their own level and be color purple

107.1 Contract Time and Contract Completion Date

This Subsection is amended by the addition of the following:

The MTA will entertain a start date that fits within the Contractor's schedule beginning after the MTA Board's approval to award, anticipated on March 26, 2026. The Contractor shall provide advance notice in accordance with Subsection 107.1.3, Limitations of Operations, prior to starting any work that requires the relocation of staff, materials, or equipment, or changes in MTA operations.

Substantial Completion, as defined in subsection 107.1.1, shall be on or before September 30, 2026.

The Contract Completion Date shall be achieved on or before October 31, 2026.

Liquidated damages will be accessed per Supplemental Specification Subsection 107.7.2 for each calendar day Contract Completion is not achieved. If substantial completion is not completed by the Contract Completion date the project disincentive, as defined in Subsection 107.1.2, and Liquidated Damages will both be incurred.

107.1.1 Substantial Completion

This Subsection is amended by the addition of the following:

Substantial completion is defined as all work has been completed in accordance with the contract documents except for final punch list items and the entire facility can be occupied and used for the purposes intended. Substantial completion includes but is not limited to the following:

- The final building cleaning has been completed by the Contractor to the Resident's satisfaction.
- All inspections required by state and/or local permits have been completed and written proof has been provided to the Resident.
- All electrical, plumbing, and HVAC systems are completely operational and ready for final testing and commissioning by the owner's agent.
- The final Test and Balance report has been provided by the contractor for approval by the Engineer of Record.
- Contractor has provided DRAFT electronic As-Built Set of documents for review.
- Contractor has provided DRAFT electronic copy of Operations and Maintenance (O&M) Manuals including warranties for review. All warranties shall begin at date of substantial completion.

Final Punch list items shall only include minor corrections, alterations, or repairs that do not affect the intended purpose of the work or final occupancy.

Supplemental Liquidated damages on a calendar day basis in accordance with Subsection 107.8 shall be assessed for each calendar day that substantial completion is not achieved.

107.1.3 Limitations of Operations

The Work shall not, in the sole opinion of the Resident or the Authority, prohibit the safe and reasonable operations of MTA staff or its customers. Fire exits, evacuation routes, corridors, elevators, and stairwells shall not be obstructed without prior approval from the MTA. The Contractor shall provide clear access to areas outside of the designated construction area(s) at all times.

The Contractor shall submit their proposed staging, storage, and construction areas to the Resident for approval. The Contractor shall be responsible for minimizing the footprint of the work area, and resulting impacts to the MTA, to the extent practical. The Authority will allow the Contractor to store materials on site in the locations designated on the plans, for the duration of the Contract. Additional space shall be coordinated and approved by the Resident in writing.

Prior to starting work, work areas shall be fully sealed off from the surrounding office spaces using heavy plastic sheeting, or other approved means, to prevent construction debris and dust from infiltrating beyond the work zone. HVAC vents into and out of the construction area shall be sealed to prevent pulling dust into the system or pushing dust out of the work zone. The contractor shall implement measures to minimize the tracking of debris through the building.

The contractor shall provide, operate, and maintain temporary HEPA filtration and negative-pressure containment to prevent construction-generated dust from migrating into active office spaces. Filtration units shall utilize true HEPA filters and shall operate continuously during dusty work until air quality meets pre-work baseline conditions.

The contractor shall protect all surfaces through construction and will be required to repair any contractor caused damage to the same or better condition as the existing at their own expense.

The Contractor shall use low-VOC and low-odor products to the greatest extent practicable throughout the Work. Any product or activity that generates noticeable or disruptive odors, as determined at the sole discretion of the Resident, shall not be used or performed during Maine Turnpike business hours. Such products or activities shall be scheduled for off-hours or alternative methods and materials shall be submitted for approval.

Work within occupied portions of the building shall be completed in an orderly manner that provides a reasonable work environment for office operations and provides safe passage and work environment for building occupants. All work areas shall be clearly blocked off and signage shall be provided to alert building occupants of the work area. Materials and tools shall not be stored outside designated work areas. The work area and adjacent surfaces shall be completely cleaned at the completion of the work within the occupied portion of the building or at the end of each workday, whichever occurs first.

The E-ZPass Retail Area, shall remain operational at all times during Maine Turnpike Normal Business Hours.

Radiant heating loops are installed within concrete slabs on all three floors. The contractor shall use a thermal imaging camera to locate and document all tubing prior to performing any slab penetrations or securement of new walls. An As-Built shall be provided to the Authority.

Removal of exterior window glass shall not be permitted.

The Contractor shall notify the Resident of any work requiring the relocation of MTA staff, equipment, workstations, or materials in advance of the required relocation in writing. The following advance notification requirements apply:

- Start of physical construction: 14 Calendar Days
- Change in construction phase, relocating staff within building: 14 Calendar Days

All relocations of MTA staff will be completed by MTA staff and occur over a weekend period beginning at 6:00 p.m. on Friday and ending at 8:00 a.m. on the following Monday.

Activities will be allowed within, or immediately adjacent to, occupied areas of the building if, in the opinion of the Resident, the work is not unreasonably disruptive to the daily work activities of MTA staff.

Activities within, or immediately adjacent to occupied areas, which are deemed by the Resident to be excessively loud (60 dBA or higher) or disruptive to normal business operations, for more than a 15-minute period of time, shall not be conducted during Maine Turnpike Normal Business Hours unless approved by the Resident. The transporting of large equipment, materials and trash through occupied portions of the building shall not occur during Maine Turnpike Normal Business Hours.

All work proposed outside of Maine Turnpike Normal Business Hours or on holidays shall be coordinated through the Resident at least seven calendar days in advance of the scheduled activities. Holiday work and Sunday work will only be allowed with advance approval of the Resident.

Authority Conference Room (Room 310): The room, and all public spaces used to access it, shall be vacated of all construction materials and all surfaces shall be completely cleaned. No work will be allowed in the immediate vicinity of the Room 310 on Board and Committee Meeting days. All electrical, and HVAC systems within room 310 shall be completely operational during board meetings. A schedule of Board and Committee Meeting dates is available on the Maine Turnpike's website at the following address: [https://maineturnpike.com/getattachment/3f107d05-06f9-4532-98fb-824ec2e06152/Board-Schedule-2026-\(005\).pdf?lang=en-US](https://maineturnpike.com/getattachment/3f107d05-06f9-4532-98fb-824ec2e06152/Board-Schedule-2026-(005).pdf?lang=en-US). Board meeting dates are subject to change. All board meeting date changes shall be made at least 14 Calendar Days prior to the scheduled meeting.

The Contractor shall be responsible for providing MTA employees with access to offices, file rooms, storage areas, equipment rooms and other spaces on an as-needed basis.

The Authority prefers that a sectional approach be used by the contractor when working through each construction area. The Authority desires to reoccupy completed sections of each construction area as soon as practical once they can be safely accessed by Authority personnel without undue impact to contractor work activities.

When work occurs within a bathroom or breakroom, it shall be closed from use with appropriate signage provided by the contractor. Only one men's bathroom, one women's bathroom, and one breakroom may be closed within the building at any one time.

No work is anticipated in the following areas but should the need arise, coordination a minimum of 7 calendar days in advanced of any work is required and special restrictions may be placed on the work activities:

- State Police Offices
- Server Room 114
- Customer Service Storage Room 173
- Notice/Mailing Room 220
- Finance Vault 323

The heating and cooling systems within the building shall not be shut down during MTA Business hours when the outdoor ambient air temperature is not between 45 and 70 degrees. At no time shall the heating or cooling systems be shut down for more than 4 hours during MTA Business hours.

The domestic water system shall not be shut down during MTA's Business Hours. If the domestic water system is shut down outside of MTA's Business hours, the contractor shall provide a porta potty for the MTA's exclusive use.

The Contractor may use the Loading Dock for deliveries. Any Contractor deliveries shall not impede daily operations of the Turnpike or their daily deliveries.

The Maine Turnpike Authority Headquarters building is a secured facility. All contractor and subcontractor employee access will be by keycard. Secured doors shall not be propped open at any time. Coordination with the MTA will be required to obtain keycards.

The Contractor shall make allowances for coordination with MTA subcontractors to work within contractor spaces as needed. The MTA subcontractors include, but are not limited to XL Automation, and Sparhawk Group (MTA Commissioning Agent).

The Contractor will not be permitted to dispose of waste, debris or other refuse in the MTA's trash bins or dumpsters.

No contractor or subcontractor employee shall bring firearms of any type into the building, or onto the building property. Any employees who bring firearms onto the property will be removed from the project site and, at the Authority's discretion, may not be allowed to return.

The MTA is a public facility, the use of profanity or derogatory language will not be tolerated. Contractor and subcontractor employees are expected to act in a responsible and professional manner. At the Authority's discretion, a contractor or subcontractor employee may be removed from the site and may not be allowed to return.

107.4.2 Schedule of Work Required

This subsection is amended by the addition of the following:

The contractor shall include MTA Subcontractor activities within their critical path schedule showing time for XL Automation and Sparhawk Group throughout the duration of the contract. The individual scope for each subcontractor is as follows:

- XL Automation will be providing pathway, control wiring and systems controls for the mechanical systems prior to and during the construction.
- Sparhawk Group will be providing final commissioning services for mechanical systems.

108.2.1 Generation of Progress Payments

The Authority will estimate the amount of Work performed at least monthly and make payment based upon such estimates. Estimates may be paid bimonthly (twice-a-month) if the bimonthly (twice-a-month) invoices exceed \$100,000. No such estimates or payment will be made if, in the judgment of the Authority, the Work is not proceeding in accordance with the provisions of the Contract. The Contractor agrees to waive all claims related to the timing and amount of such estimates.

108.2.3 Mobilization Payment

The second paragraph is deleted in its entirety and replaced with the following:

Upon approval of all pre-construction submittals required for approval by this Contract, including those listed in Section 104.4.2 – Preconstruction Conference, the Contractor will receive payment of 50% of the Lump Sum price for Mobilization, not to exceed 5% of the Bid less the

amount bid for Mobilization. After the Authority determines that the Work is 50% complete and the Contractor has submitted a Draft (50%) as-built submittal of all underground work to date (within the prior 30 day pay period) as defined in Special Provision 105., the Contractor will receive the other 50% of the Lump Sum price for Mobilization, not to exceed 5% of the Bid less the amount bid for Mobilization. Any remaining Mobilization will be at the completion of physical work.

108.3 Retainage

The seventh paragraph is deleted in its entirety and replaced with the following:

When requested by the Contractor, an 80 percent reduction of retainage will be considered by the Authority when the Project is substantially complete and the Contractor has submitted a Final Draft (98%) as-built submittal of all work, in accordance with Special Provision 105. When requesting a reduction, the Contractor shall include an explanation of the outstanding Work, an estimate of the cost to complete the Work, and a schedule for completing the Work. Seasonal limitations as well as warranty and establishment periods (for vegetation) shall be addressed.

110.3.05 Umbrella Liability

The following sentence is added:

The Maine Turnpike Authority shall be included as an "Additional Insured" by Endorsement to the policy. A "Waiver of Subrogation Endorsement" in favor of the Maine Turnpike Authority shall be a part the policy. The Contractor shall be responsible for any deductibles stated in the policy.

110.3.2 Commercial General Liability

The following sentence is added:

The Maine Turnpike Authority shall be included as an "Additional Insured" by Endorsement to the policy. A "Waiver of Subrogation Endorsement" in favor of the Maine Turnpike Authority shall be a part the policy. The Contractor shall be responsible for any deductibles stated in the policy.

SPECIAL PROVISION

SECTION 631

EQUIPMENT RENTAL

(Electrician)
(Electrician's Apprentice)
(Plumber)
(Plumber's Apprentice)
(HVAC Technician)
(HVAC Apprentice)

631.02 General

The following paragraphs are added:

Electrician – Licensed by State of Maine.

Electrician's Apprentice – Enrolled in an accredited program, proof shall be submitted to Resident for verification.

Plumber – Licensed by State of Maine appropriate for the work being performed.

Plumber's Apprentice – Enrolled in an accredited program, proof shall be submitted to Resident for verification.

HVAC Technician – Licensed by State of Maine appropriate for the work being performed.

HVAC Apprentice – Enrolled in an accredited program, proof shall be submitted to Resident for verification.

631.08 Basis of Payment

The following paragraphs are added:

Such related costs such as use of hand tools, meal and room expenses, benefits, insurance, retirement, travel time, overtime, overhead and profit will not be measured separately for payment, but shall be incidental to the unit price for the bid item.

Note: For extra materials required for miscellaneous work the General Contractor shall be allowed 15 percent overhead and profit on the cost of materials and rental equipment (not covered by miscellaneous unit items). Rates for Subcontractor owned equipment required to perform miscellaneous work, not otherwise provided for in the Contract, shall be negotiated.

The General Contractor will be allowed 5 percent overhead and profit on the subcontractor's cost of materials, and subcontractors rented equipment (not covered by miscellaneous unit items). The General Contractor shall include his markup on the Subcontractor's labor in the pay items.

The labor hour bid items shall include labor and labor burdens, benefits, supervision, transportation, travel time and allowances, overnights, small tools and equipment, subcontractor overhead and profit, and General Contractor overhead and profit. Time will be measured from the start of work to the stoppage of work at the project site; less the time taken for lunch. No deduction of time will be taken for the standard morning "coffee break".

<u>Pay Item</u>		<u>Pay Unit</u>
631.53	Electrician	Hour
631.54	Electrician's Apprentice	Hour
631.55	Plumber	Hour
631.56	Plumber's Apprentice	Hour
631.57	HVAC Technician	Hour
631.58	HVAC Apprentice	Hour

SPECIAL PROVISIONSECTION 800BUILDING AND STRUCTURES

(Maine Turnpike Headquarters Building Renovation)

800.1 Description

All work shall be completed in accordance with the contract Plans and the requirements of Appendix A of the contract Specifications.

The Contractor shall submit to the Resident for approval a cost breakdown of the major components of work, by Division, for sections 01 through 27. This breakdown will be used as a basis for monthly pay estimates.

800.3 Method of Measurement

Maine Turnpike Headquarters Building Renovation will be measured for payment by the lump sum, complete and accepted.

800.4 Basis of Payment

The Lump Sum payment for the Maine Turnpike Headquarters Building Renovation shall be full compensation for the cost of furnishing all materials, equipment, supplies, tools, incidentals, labor and supervision necessary to satisfactorily complete the work in all respects, in accordance with the Contract Documents and to the satisfaction of the Resident.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
800.01 Maine Turnpike Headquarters Building Renovation	Lump Sum

APENDIX A

AIA Specifications

SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Demolition and removal of selected portions of building.
2. Salvage of existing items to be reused in the new work.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- C. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

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

1.5 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.
 1. Inspect and discuss condition of construction to be selectively demolished.
 2. Review structural load limitations of existing structure.
 3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.6 FIELD CONDITIONS

- A. Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 1. Maintain fire-protection facilities in service during selective demolition operations.

1.7 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.
- B. Notify warrantor on completion of selective demolition and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.8 COORDINATION

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

3.3 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

B. Remove temporary barricades and protections where hazards no longer exist.

3.4 SELECTIVE DEMOLITION, GENERAL

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

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.

5. Maintain fire watch during and for at least 2 hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly.

B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

3.5 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

3.6 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel framing and supports for countertops.
 - 2. Steel framing and supports for audio-visual equipment.
 - 3. Steel framing and supports for mechanical and electrical equipment.
 - 4. Steel framing and supports for applications where framing and supports are not specified in other Sections.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. 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.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Paint products.
 - 2. Grout.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
 - 1. Steel framing and supports for countertops.
 - 2. Steel framing and supports for applications where framing and supports are not specified in other Sections.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer.
- B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.
- C. Welding certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
 - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- E. Steel Tubing: ASTM A 500/A 500M, cold-formed steel tubing.
- F. Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

- G. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
 - 1. Size of Channels: 1-5/8 by 1-5/8 inches, unless indicated otherwise.
 - 2. Material: Galvanized steel, ASTM A 653/A 653M, structural steel, Grade 33, with G90 coating; 0.079-inch nominal thickness.
 - 3. Material: Cold-rolled steel, ASTM A 1008/A 1008M, structural steel, Grade 33; 0.0677-inch minimum thickness; hot-dip galvanized after fabrication.
- H. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.
- I. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.
- J. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.
- K. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
- L. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500.

2.2 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless-steel fasteners for fastening aluminum.
 - 2. Provide stainless-steel fasteners for fastening stainless steel.
 - 3. Provide stainless-steel fasteners for fastening nickel silver.
 - 4. Provide bronze fasteners for fastening bronze.
- 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. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1.
- D. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- E. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

F. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

2.3 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting." And Section 099123 Interior Painting."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.4 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 value 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 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 contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are 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. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.5 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.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.6 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 and prime exterior miscellaneous steel trim.

2.7 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.8 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with universal shop primer.
- D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning." or SSPC-SP 3, "Power Tool Cleaning." requirements indicated below:
 - 1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 3. Other Items: SSPC-SP 3, "Power Tool Cleaning."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.9 ALUMINUM FINISHES

- A. As-Fabricated Finish: AA-M12.
- B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

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 racking; 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 screws, 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 come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

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.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting." And Section 099123 "Interior Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 055000

SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Framing with dimension lumber.
2. Wood blocking, cants, and nailers.
3. Wood furring and grounds.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal or greater size but less than 5 inches nominal size in least dimension.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 2. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 1. Preservative-treated wood.
 2. Post-installed anchors.
 3. Metal framing anchors.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. 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.
- B. Maximum Moisture Content of Lumber: 15 percent.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
 - 1. Treatment shall not promote corrosion of metal fasteners.
 - 2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.
 - 3. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664, and design value adjustment factors shall be calculated according to ASTM D 6841.
- C. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
- D. Application: Treat the following:
 - 1. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Furring.
 - 4. Grounds.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.
- C. 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.
- D. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preserved treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Screws for Fastening to Metal Framing: ASTM C 1002, length as recommended by screw manufacturer for material being fastened.
- D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC308 as appropriate for the substrate.
 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.6 METAL FRAMING ANCHORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Cleveland Steel Specialty Co.
 2. KC Metals Products, Inc.
 3. Phoenix Metal Products, Inc.
 4. Simpson Strong-Tie Co., Inc.
 5. USP Structural Connectors.
- B. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.
 1. Use for interior locations unless otherwise indicated.
- C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 coating designation; and not less than 0.036 inch thick.
 1. Use for wood-preserved-treated lumber and where indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- C. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- 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. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- G. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 - 1. Use inorganic boron for items that are continuously protected from liquid water.
 - 2. Use copper naphthenate for items not continuously protected from liquid water.
- H. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
 - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
 - 3. ICC-ES evaluation report for fastener.
- I. Use steel common 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. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 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 miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 062023 - INTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior Trim.
- B. Related Requirements:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view.
 - 2. Section 099123 "Interior Painting" for priming and backpriming of interior finish carpentry.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
- B. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
- B. Deliver interior finish carpentry materials only when environmental conditions comply with requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions comply with requirements specified for installation areas.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 INTERIOR TRIM

- A. Cellular PVC Trim: Extruded, expanded PVC with a small-cell microstructure, recommended by manufacturer for exterior use, made from UV- and heat-stabilized rigid material.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Kommerling USA, Inc.
 - c. Royal Mouldings Limited.
 - 2. Density: Not less than 31 lb/cu. ft.
 - 3. Heat Deflection Temperature: Not less than 130 deg F, according to ASTM D 648.
 - 4. Coefficient of Thermal Expansion: Not more than $4.5 \times 10(-5)$ inches/inch x deg F.
 - 5. Water Absorption: Not more than 1 percent, according to ASTM D 570.
 - 6. Flame-Spread Index: 75 or less, according to ASTM E 84.

2.2 MISCELLANEOUS MATERIALS

- A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
- B. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
- C. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours.

3.3 INSTALLATION, GENERAL

- A. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
 - 1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 2. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
 - 3. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 ADJUSTING

- A. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.5 CLEANING

- A. Clean interior finish carpentry on exposed and semiexposed surfaces. Restore damaged or soiled areas and touch up factory-applied finishes if any.

3.6 PROTECTION

- A. Protect installed products from damage from weather and other causes during construction.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062023

SECTION 064116 - PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Plastic-laminate-faced architectural cabinet fronts.
- B. Related Requirements:
 1. Section 123661.16 "Solid Surfacing Countertops."

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For plastic-laminate-faced architectural cabinet fronts.
 1. Include plans, elevations, sections, and attachment details.
 2. Show large-scale details.
 3. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
 4. Apply AWI Quality Certification Program label to Shop Drawings.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's or fabricator's standard size. Architect will select up to 6 colors/patterns for verification samples.
- D. Samples for Initial Selection: For each type of exposed finish.
- E. Samples for Verification: For the following:
 1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.

- a. Provide one sample applied to core material with specified edge material applied to one edge.
2. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and fabricator.
- B. Product Certificates: For each type of product.
- C. Quality Standard Compliance Certificates: AWI Quality Certification Program.

1.6 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.
 1. Shop Certification: AWI's Quality Certification Program accredited participant.
- B. Installer Qualifications: AWI's Quality Certification Program accredited participant.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver cabinet fronts until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.8 FIELD CONDITIONS

- A. Field Measurements: Where cabinet fronts are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of cabinets indicated for construction, finishes, installation, and other requirements.

- B. Grade: Custom.
- C. Type of Construction: Match existing.
- D. Door and Drawer-Front Style: Match existing.
 - 1. Reveal Dimension: To be determined with Architect.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or if not indicated, as required by quality standard.
- F. Laminate Cladding for Exposed Surfaces:
 - 1. Vertical Surfaces: Grade HGS.
 - 2. Edges: Grade HGS matching laminate in color, pattern, and finish.
 - 3. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.
- G. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. Match Architect's sample.
 - 2. As selected by Architect from laminate manufacturer's full range in the following categories:
 - a. Solid colors, matte finish.
 - b. Solid colors with core same color as surface, matte finish.
 - c. Wood grains, matte finish.
 - d. Patterns, matte finish.

2.2 CABINET HARDWARE AND ACCESSORIES

- A. Hinges: Re-use existing.
- B. Back-Mounted Pulls: BHMA A156.9, B02011.
- C. Wire Pulls: Back mounted, solid metal, 5 inches long.
- D. Door and Drawer Silencers: BHMA A156.16, L03011.
- E. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
 - 1. Satin Stainless Steel: BHMA 630.
- F. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.3 FABRICATION

- A. Fabricate architectural cabinet fronts to dimensions, profiles, and details based on field documentation and drawings.
- B. Shop-cut openings to maximum extent possible. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition cabinet fronts to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

- A. Grade: Install cabinet fronts to comply with quality standard grade of item to be installed.
- B. Assemble and complete fabrication at Project site to extent that it was not completed in the shop.
- C. Install cabinet fronts level, plumb, and true in line.
 - 1. Install cabinet fronts without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective cabinet fronts, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semi exposed surfaces.

END OF SECTION 064116

SECTION 064600 – ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Interior standing and running trim.

- B. Related Requirements:

- 1. Section 061000 "Rough Carpentry" for wood furring, blocking, and shims required for installing wood trim and concealed within other construction before wood trim installation.

1.3 ACTION SUBMITTALS

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

- 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

- 1. Show details full size.
 - 2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 3. Apply WI Certified Compliance Program label to Shop Drawings.
 - 4. Apply AWI Quality Certification Program label to Shop Drawings.

- C. Samples for Initial Selection:

- 1. Hardwood lumber.

- D. Samples for Verification:

- 1. Lumber for transparent finish, not less than 5 inches wide by 12 inches long, for each species and cut, finished on one side and one edge.

1.4 INFORMATIONAL SUBMITTALS

- A. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.5 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. Installer Qualifications: Certified participant in AWI's Quality Certification Program.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver wood trim until operations that could damage wood trim have been completed in installation areas. If wood trim must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.7 FIELD CONDITIONS

- A. Environmental Limitations for Interior Work: Do not deliver or install interior wood trim until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.

1.8 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that wood trim can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 WOOD TRIM, GENERAL

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of wood trim indicated for construction, finishes, installation, and other requirements.
 1. Provide certificates from AWI certification program indicating that woodwork complies with requirements of grades specified.

2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

2.2 INTERIOR STANDING AND RUNNING TRIM FOR TRANSPARENT FINISH

- A. Grade: Custom.
- B. Wood Species and Cut: Match existing Oak species and cut for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.
- C. Profile: Match existing.

2.3 WOOD MATERIALS

- A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of wood trim and quality grade specified unless otherwise indicated.
 1. Wood Moisture Content for Interior Materials: 5 to 10 percent.

2.4 MISCELLANEOUS MATERIALS

- A. Interior Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

2.5 FABRICATION

- A. Fabricate wood trim to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
- B. Backout or groove backs of flat trim members and kerf backs of other wide, flat members except for members with ends exposed in finished work.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition wood trim to average prevailing humidity conditions in installation areas.

B. Before installing architectural wood trim, examine shop-fabricated work for completion and complete work as required, including removal of packing.

3.2 INSTALLATION

- A. Grade: Install wood trim to comply with same grade as item to be installed.
- B. Assemble wood trim and complete fabrication at Project site to the extent that it was not completed in the shop.
- C. Install wood trim level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut wood trim to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor wood trim to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails for exposed fastening, countersunk and filled flush with woodwork.
- F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 60 inches long except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
 1. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.
- G. Touch up finishing work specified in this Section after installation of wood trim. Fill nail holes with matching filler where exposed.
- H. Refer to Section 099123 "Interior Painting" and Section 099300 "Staining and Transparent Finishing" for final finishing of installed wood trim.

3.3 ADJUSTING AND CLEANING

- A. Repair damaged and defective wood trim, where possible, to eliminate functional and visual defects; where not possible to repair, replace wood trim. Adjust joinery for uniform appearance.
- B. Clean wood trim on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064600

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DEFINITIONS

- A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in, or construction joints between, fire rated walls and floor assemblies.

1.3 SUMMARY

- A. Section Includes:

- 1. Penetrations in fire-resistance-rated walls and floors.

1.4 RELATED WORK

- A. Division 22 – Plumbing
- B. Division 23 – Mechanical
- C. Division 26 – Electrical
- D. Division 27 – Communications
- E. Division 28 – Alarm Systems

1.5 REFERENCES

- A. Test Requirements: ASTM E 814 “Standard Method of Fire Tests of Through Penetration Fire Stops”
- B. Test Requirement: UL 1479, “Fire Tests of Through-Penetration Firestops”
- C. Test Requirements: UL 2079, “Tests for Fire Resistance of Building Joint Systems”

- D. Underwriters Laboratory (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
- E. Fire stop systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads or traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.
- F. For those firestop applications that exist for which no qualified tested system is available through a manufacturer, an engineering judgement derived from similar qualified tested system designs or other tests will be submitted to local authorities for their review and approval prior to installation. Engineering judgement documents must follow requirements set forth by the International Firestop Council.

1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.7 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.8 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.9 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.12 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
 - 1) UL in its "Fire Resistance Directory."
 - 2) Intertek Group in its "Directory of Listed Building Products."
 - 3) FM Global in its "Building Materials Approval Guide."

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration

firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

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. 3M Fire Protection Products.
- b. A/D Fire Protection Systems Inc.
- c. Construction Solutions.
- d. Grabber Construction Products.
- e. Hilti, Inc.
- f. HOLDRITE.
- g. NUCO Inc.
- h. Specified Technologies, Inc.
- i. Tremco, Inc.

B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

- 1. Permanent forming/damming/backing materials.
- 2. Substrate primers.
- 3. Collars.
- 4. Steel sleeves.

2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.

- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. 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.
- H. 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. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

2.4 MIXING

- A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping 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 the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with 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 penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming 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.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
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 the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels

with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping 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 penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SYSTEM SCHEDULE

- A. Provide UL-classified systems. Refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ for the following penetration firestopping conditions:
- B. Penetration Firestopping Systems with No Penetrating Items.
- C. Penetration Firestopping Systems for Metallic Pipes, Conduit, or Tubing.
- D. Penetration Firestopping Systems for Nonmetallic Pipe, Conduit, or Tubing.

- E. Penetration Firestopping Systems for Electrical Cables.
- F. Penetration Firestopping Systems for Cable Trays with Electric Cables.
- G. Penetration Firestopping Systems for Miscellaneous Electrical Penetrants.
- H. Penetration Firestopping Systems for Miscellaneous Mechanical Penetrants.
- I. Penetration Firestopping Systems for Groupings of Penetrants.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Mildew-resistant joint sealants.
 - 2. Butyl joint sealants.
 - 3. Latex joint sealants.
- B. Related Requirements:
 - 1. Section 079219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.

- B. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- C. Field-Adhesion-Test Reports: For each sealant application tested.
- D. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
 - 1. Conduct field tests for each kind of sealant and joint substrate.
 - 2. Notify Architect seven days in advance of dates and times when test joints will be erected.
 - 3. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
 - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 - 4. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
 - 5. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.8 FIELD 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.

1.9 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, 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. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Dow Corning Corporation.
- b. GE Construction Sealants; Momentive Performance Materials Inc.
- c. Pecora Corporation.
- d. Soudal USA.
- e. Tremco Incorporated.

2.3 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Bostik, Inc.
- b. Pecora Corporation.

2.4 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Franklin International.
- b. May National Associates, Inc.; a subsidiary of Sika Corporation.
- c. Pecora Corporation.
- d. Sherwin-Williams Company (The).
- e. Tremco Incorporated.

2.5 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Alcot Plastics Ltd.
- b. BASF Corporation; Construction Systems.

c. Construction Foam Products; a division of Nomaco, Inc.

- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin), 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 performance of the Work.
- 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. 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.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Inspect tested joints and report on the following:
 - a. Whether sealants filled joint cavities and are free of voids.
 - b. Whether sealant dimensions and configurations comply with specified requirements.
 - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
2. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

3.5 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
 - 1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Acrylic latex.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
 - 1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Silicone, mildew resistant, acid curing.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Concealed mastics.
 - 1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
 - 2. Joint Sealant: Butyl-rubber based.
 - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 079200

SECTION 079219 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes acoustical joint sealants.
- B. Related Requirements:
 - 1. Section 079200 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for nonacoustical applications.

1.3 ACTION SUBMITTALS

- A. Product Data: For each acoustical joint sealant.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Acoustical-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For special warranties.

1.5 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish acoustical joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E 90.

2.2 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C 834.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- Accumetric LLC.
- Franklin International.
- GE Construction Sealants; Momentive Performance Materials Inc.
- Grabber Construction Products.
- Hilti, Inc.
- OSI Sealants; Henkel Corporation.
- Pecora Corporation.
- Tremco Incorporated.
- United States Gypsum Company.

2. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

B. Acoustical Sealant for Concealed Joints: Manufacturer's standard nonsag, nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber acoustical sealant.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- Pecora Corporation.
- Serious Energy Inc.

2.3 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.
- 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 acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- 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 acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer. 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 ACOUSTICAL JOINT SEALANTS

- A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.
- B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint

sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C 919, ASTM C 1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

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 acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079219

SECTION 081213 - HOLLOW METAL FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Interior standard steel frames.
- B. Related Requirements:
 - 1. Section 087100 "Door Hardware" for door hardware for wood doors.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, fire-resistance ratings, and finishes.
- B. Shop Drawings: Include the following:

1. Elevations of each frame type.
2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
3. Locations of reinforcement and preparations for hardware.
4. Details of each different wall opening condition.
5. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.

C. Product Schedule: For hollow-metal frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.7 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal frame assembly, for tests performed by a qualified testing agency.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non-vented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal frames vertically under cover at Project site with head up. Place on minimum 4-inch-high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.2 STANDARD STEEL FRAMES

- A. Construct hollow-metal frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Interior Frames: SDI A250.8.
 - 1. Materials: Steel sheet, minimum thickness of 0.053 inch.
 - 2. Transom Frames: Fabricated from same thickness material as adjacent door frame.
 - 3. Construction: Knocked down.
 - 4. Exposed Finish: Prime.

2.3 BORROWED LITES

- A. Fabricate of steel sheet, minimum thickness of 0.053 inch.
- B. Construction: Knocked down.
- C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

2.4 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 - 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
- B. Material: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

2.5 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

D. Glazing: Comply with requirements in Section 088000 "Glazing" and Section 088813 "Fire-rated Glazing."

2.6 FABRICATION

A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Transom Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.

B. Hardware Preparation: Factory prepare hollow-metal frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal frames for hardware.

C. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
2. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

2.7 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Drill and tap frames to receive non-tempered, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. General: Install hollow-metal frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions. Comply with SDI A250.11.
- B. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
 1. Install frames with removable stops located on secure side of opening.
- C. Fire-Rated Openings: Install frames according to NFPA 80.
- D. Solidly pack mineral-fiber insulation inside frames.
- E. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 4. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- F. Glazing: Comply with installation requirements in Section 088000 "Glazing", Section 088813 "Fire-resistant Glazing" and with hollow-metal manufacturer's written instructions.

3.3 CLEANING AND TOUCHUP

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081213

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid-core doors with wood-veneer faces.
- B. Related Requirements:
 - 1. Section 088000 "Glazing" for glass view panels in flush wood doors.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.
- B. 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.
- C. Samples for Initial Selection: For factory-finished doors.
- D. Samples for Verification:
 - 1. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.

- a. Provide Samples for each species of veneer and solid lumber required.
- b. Finish veneer-faced door Samples with same materials proposed for factory-finished doors.
2. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For special warranty.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in plastic bags or cardboard cartons.
- C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.7 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.
- B. 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 temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during remainder of construction period.

1.8 WARRANTY

- A. A. 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 Exterior Doors: Five years from date of Substantial Completion.
4. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ABS- American Building Supply- Doormerica.
 2. Algoma Hardwoods, Inc.
 3. Ampco Products, LLC.
 4. Construction Specialties, Inc.
 5. Eggers Industries.
 6. Graham Wood Doors; ASSA ABLOY Group company.
 7. Ipik Door Company.
 8. Marlite.
 9. Mohawk Flush Doors, Inc.
 10. Oshkosh Door Company.
 11. VT Industries Inc.
- B. Source Limitations: Obtain flush wood doors 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 or WDMA I.S.1-A, "Architectural Wood Flush Doors."

 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. WDMA I.S.1-A Performance Grade: Standard Duty.
- C. WDMA I.S.1-A Performance Grade:
 1. Standard Duty unless otherwise indicated.
- 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. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, 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.
2. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
3. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
4. 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. Particleboard-Core Doors:

1. Particleboard: ANSI A208.1, Grade LD-1.
2. Blocking: Provide wood blocking in particleboard-core doors as follows:
 - a. 5-inch top-rail blocking, in doors indicated to have closers.
 - b. 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
3. Provide doors with glued-wood-stave or structural-composite-lumber cores instead of particleboard cores for doors indicated to receive exit devices.

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:

1. Grade: Premium, with Grade A faces.
2. Species: Red Oak (MATCH EXISTING).
3. Cut: Match existing.
4. Match between Veneer Leaves: Book match.
5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Pair and Set Match: Provide for doors hung in same opening.
7. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 20 feet or more.
8. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
9. Exposed Vertical Edges: Same species as faces - edge Type A.
10. Core: Particleboard, 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. WDMA I.S.1-A Performance Grade: Standard Duty.

2.4 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.
- C. 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."

2.5 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.
- C. Transparent Finish:
 1. Grade: Premium.
 2. Finish: AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" System 5, conversion varnish.
 3. Staining: None required.
 4. Sheen: Satin (match existing).

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. 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.
- C. 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.

D. 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 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Mechanical door hardware for the following:
 - a. Swinging doors.

- B. Related Requirements:

1. Section 064116 "Plastic-Laminate-Faced Architectural Cabinets" for cabinet door hardware provided with cabinets.

1.3 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, keying, and access control with Owner'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.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 1. Conference participants shall include Installer's Architectural Hardware Consultant and Owner's security consultant.
- B. Keying Conference: Conduct conference at Project site.

1. Conference participants shall include Installer's Architectural Hardware Consultant and Owner's security consultant.
2. Incorporate conference decisions into keying schedule after reviewing door hardware keying system including, but not limited to, the following:
 - a. Flow of traffic and degree of security required.
 - b. Preliminary key system schematic diagram.
 - c. Requirements for key control system.
 - d. Requirements for access control.
 - e. Address for delivery of keys.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. 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.
- C. Samples for Initial Selection: For each type of exposed finish.
- D. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. 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 Documents.
 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.

E. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and Architectural Hardware Consultant.
- 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. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of door hardware to include in maintenance manuals.
- B. Schedules: Final door hardware and keying schedule.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
 - 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 Architectural Hardware Consultant (AHC) and an Electrified Hardware Consultant (EHC).

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.
- C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- D. Deliver keys to Owner at premises.

1.10 WARRANTY

- A. 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.

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. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. 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.
- D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the DOJ's "2010 ADA Standards for Accessible Design" 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. Sliding or Folding Doors: 5 lbf applied parallel to door at latch.
 - c. 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 and on Drawings.

2.4 HINGES

- A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on wood doors and hollow-metal frames.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Baldwin Hardware Corporation.
 - b. Bommer Industries, Inc.
 - c. Hager Companies.
 - d. Lawrence Hardware Inc.
 - e. McKinney Products Company; an ASSA ABLOY Group company.
 - f. Stanley Commercial Hardware; a division of Stanley Security Solutions.

2.5 MECHANICAL LOCKS AND LATCHES

- A. Lock Functions: As indicated in door hardware schedule.
- B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Bored Locks: Minimum 1/2-inch latchbolt throw.
 - 2. Mortise Locks: Minimum 3/4-inch latchbolt throw.
 - 3. Deadbolts: Minimum 1.25-inch bolt throw.
- C. Lock Backset: 2-3/4 inches unless otherwise indicated.
- D. Lock Trim:
 - 1. Description: Manufacturer's standard.
 - 2. Levers: Wrought – Match existing.
 - a. ADA compliant profile.
 - 3. Escutcheons (Roses): Wrought.
 - 4. Dummy Trim: Match lever lock trim and escutcheons.
- E. 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. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
 - 3. Aluminum-Frame Strike Box: Manufacturer's special strike box fabricated for aluminum framing.
- F. Bored Locks: BHMA A156.2; Grade 1; Series 4000.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Best Access Systems; Stanley Security Solutions, Inc.
 - b. Corbin Russwin, Inc.; an ASSA ABLOY Group company.
 - c. SARGENT Manufacturing Company; ASSA ABLOY.
- G. Mortise Locks: BHMA A156.13; Operational Grade 1; stamped steel case with steel or brass parts; Series 1000.

2.6 AUXILIARY LOCKS

- A. Bored Auxiliary Locks: BHMA A156.36: Grade 1; with strike that suits frame.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Best Access Systems; Stanley Security Solutions, Inc.
 - b. Corbin Russwin, Inc.; an ASSA ABLOY Group company.
 - c. SARGENT Manufacturing Company; ASSA ABLOY

2.7 ELECTRIC STRIKES

- A. Electric Strikes: BHMA A156.31; Grade 1; with faceplate to suit lock and frame.

2.8 LOCK CYLINDERS

- A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Best Access Systems; Stanley Security Solutions, Inc.
 - b. Corbin Russwin, Inc.; an ASSA ABLOY Group company.
 - c. SARGENT Manufacturing Company; ASSA ABLOY
- B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.
 1. Core Type: Interchangeable.
- C. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
- D. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.9 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock.
 1. Existing System:
 - a. Master key or grand master key locks to Owner's existing system.
 - b. Re-key Owner's existing master key system into new keying system.
 2. Keyed Alike: Key all cylinders to same change key.
- B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

- a. Notation: Information to be furnished by Owner.

2.10 OPERATING TRIM

- A. Operating Trim: BHMA A156.6; stainless steel unless otherwise indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc.
 - b. Burns Manufacturing Incorporated.
 - c. Don-Jo Mfg., Inc.
 - d. Hager Companies.
 - e. Hiawatha, Inc; a division of the Activar Construction Products Group.
 - f. Rockwood Manufacturing Company; an ASSA ABLOY Group company.
 - g. Trimco.

2.11 MECHANICAL STOPS AND HOLDERS

- A. Wall- and Floor-Mounted Stops: BHMA A156.16.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc.
 - b. Architectural Builders Hardware Mfg., Inc.
 - c. Baldwin Hardware Corporation.
 - d. Burns Manufacturing Incorporated.
 - e. Door Controls International, Inc.
 - f. Hiawatha, Inc; a division of the Activar Construction Products Group.
 - g. Rockwood Manufacturing Company; an ASSA ABLOY Group company.
 - h. Trimco.

2.12 METAL PROTECTIVE TRIM UNITS

- A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc.
 - b. Burns Manufacturing Incorporated.

- c. Hager Companies.
- d. Hiawatha, Inc; a division of the Activar Construction Products Group.
- e. Pawling Corporation.
- f. Rockwood Manufacturing Company; an ASSA ABLOY Group company.
- g. Trimco.

2. Size: 6" high at kickplate; 30" high at armor plate. Width of door less 2 inches.

2.13 AUXILIARY DOOR HARDWARE

- A. Auxiliary Hardware: BHMA A156.16.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allegion plc.
 - b. Baldwin Hardware Corporation.
 - c. Hager Companies.
 - d. Rockwood Manufacturing Company; an ASSA ABLOY Group company.
 - e. Trimco.

2.14 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.
 - 3) Closers to doors and frames.
3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.15 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 indicated on Drawings and 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. Custom Steel Doors and Frames: HMMA 831.
 - 3. 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.
 - 1. Replace construction cores with permanent cores as directed by Owner.
 - 2. Furnish permanent cores to Owner for installation.
- E. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings. Verify location with Architect.
 - 1. Configuration: Provide one power supply for each door opening with electrified door hardware.
- F. 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.

3.4 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.
- B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer 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.

3.5 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.

3.6 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.
- B. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door and door hardware operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.7 DEMONSTRATION

- A. Engage Installer to train Owner's maintenance personnel to adjust, operate, and maintain door hardware.

3.8 DOOR HARDWARE SCHEDULE

ALL FINISHES SHALL BE US26D

CARD READERS PROVIDED BY OWNER – INSTALLED BY CONTRACTOR

HARDWARE SETS

HW-1 NEW INTERIOR SINGLE DOOR 317A

3 BUTTS
1 BORED LEVER LATCHSET – PASSAGE FUNCTION
1 DOORSTOP
3 FRAME SILENCERS

HW-2 NEW INTERIOR SINGLE DOOR 328A

3 BUTTS
1 MORTISED LEVER LOCKSET - STORAGE FUNCTION
1 DOORSTOP
1 KICKPLATE
3 FRAME SILENCERS

HW-3 EXISTING INTERIOR SINGLE DOOR 336

1 CARD READER AT OPEN OFFICE 331 SIDE OF OPENING
BALANCE OF EXISTING HARDWARE TO REMAIN

HW-4 NEW INTERIOR SINGLE DOOR 334 AND 349A

3 BUTTS
1 MORTISED LOCKSET – OFFICE FUNCTION
1 DOORSTOP
3 FRAME SILENCERS

HW-5 EXISTING INTERIOR SINGLE DOOR 321

1 BORED LEVER LATCHSET – PRIVACY FUNCTION WITH OCCUPANCY INDICATOR
BALANCE OF HARDWARE TO REMAIN

HW-6 EXISTING INTERIOR SINGLE DOOR 218

3 BUTTS
1 BORED LEVER LATCHSET – PASSAGE FUNCTION
REMOVE EXISTING CLOSER, PATCH AND PAINT HOLES IN FRAME
DOORSTOP AND FRAME SILENCERS TO REMAIN

END OF HARDWARE SETS

END OF SECTION 087100

SECTION 088000 – GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:

1. Glass for doors and interior borrowed lites.
2. Glazing sealants and accessories.

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. IBC: International Building Code.

1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review temporary protection requirements for glazing during and after installation.

1.6 ACTION SUBMITTALS

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

- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- D. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For glass.
- B. Sample Warranties: For special warranties.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AGC Glass Company North America, Inc.

2. Cardinal Glass Industries.
3. Gardner Glass, Inc.
4. GGI; General Glass International.
5. Glasswerks LA, Inc.
6. GTI; Glaz-Tech Industries.
7. Guardian Industries Corp.; SunGuard.
8. Hartung Glass Industries.
9. JE Berkowitz, LP.
10. Northwestern Industries, Inc.
11. Oldcastle BuildingEnvelope™.
12. Pilkington North America.
13. PPG Flat Glass; PPG Industries, Inc.
14. Schott North America, Inc.
15. Tecnoglass.
16. Trulite Glass & Aluminum Solutions, LLC.
17. Vetrotech Saint-Gobain.
18. Viracon, Inc.

- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
- C. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 1. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

- B. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
- C. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. 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.
- C. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, 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.

2.5 GLAZING SEALANTS

- A. General:
 - 1. Compatibility: Compatible with one another and with other materials they 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. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Dow Corning Corporation.
b. GE Construction Sealants; Momentive Performance Materials Inc.
c. May National Associates, Inc.; a subsidiary of Sika Corporation.
d. Pecora Corporation.
e. Sika Corporation.
f. Tremco Incorporated.
- C. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BASF Corporation; Construction Systems.
b. Dow Corning Corporation.
c. GE Construction Sealants; Momentive Performance Materials Inc.
d. May National Associates, Inc.; a subsidiary of Sika Corporation.
e. Pecora Corporation.
f. Polymeric Systems, Inc.
g. Sika Corporation.
h. Tremco Incorporated.

2.6 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with 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 of 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.

2.7 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit 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.
 - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
 - 2. Presence and functioning of weep systems.
 - 3. Minimum required face and edge clearances.
 - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 GLAZING, GENERAL

- A. 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.

- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. 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.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. 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.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- J. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.

- D. 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.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. 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.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. 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 buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.6 MONOLITHIC GLASS SCHEDULE

- A. Glass Type: Clear annealed, heat-strengthened and fully tempered float glass.
 - 1. Minimum Thickness: 6 mm.
 - 2. Provide fully tempered at doors and borrowed lites adjacent to doors.

END OF SECTION 088000

SECTION 088813 - FIRE-RESISTANT GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Fire-protection-rated glazing.

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product; 12 inches square.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installers and glass testing agency.
- B. Product Certificates: For each type of glass and glazing product, from manufacturer.

C. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install fire-resistant glazing until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.

B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; deterioration of glazing materials; or other defects in construction.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organization below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.

2.4 GLASS PRODUCTS

A. Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class I (clear) unless otherwise 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.

2.5 FIRE-PROTECTION-RATED GLAZING

A. Fire-Protection-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 257 or UL 9, including the hose-stream test, and shall comply with NFPA 80.

1. Fire-protection-rated glazing required to have a fire-protection rating of 20 minutes shall be exempt from the hose-stream test.

B. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name; test standard; whether glazing is permitted to be used in doors or openings; if permitted in openings, whether or not glazing has passed the hose-stream test; whether or not glazing meets 450 deg F (250 deg C) temperature-rise limitation; and the fire-resistance rating in minutes.

C. Fire-Protection-Rated Tempered Glass: 6-mm thickness, fire-protection-rated tempered glass; and complying with 16 CFR 1201, Category II.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AGC Glass Company North America, Inc.
 - b. SAFTI FIRST Fire Rated Glazing Solutions.
 - c. Technical Glass Products.
 - d. Vetrotech Saint-Gobain.

2.6 GLAZING ACCESSORIES

A. Provide glazing gaskets, glazing sealants, glazing tapes, setting blocks, spacers, edge blocks, and other glazing accessories that are compatible with glazing products and each other and are approved by testing agencies that listed and labeled fire-resistant glazing products with which products are used for applications and fire-protection ratings indicated.

B. Glazing Sealants for Fire-Rated Glazing Products: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated.

- C. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; 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.
- D. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. AAMA 810.1, 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.

2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with manufacturing and installation tolerances, including those for size, squareness, and offsets at corners, and for compliance with minimum required face and edge clearances.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate fire side and protected side. Label or mark units as needed so that fire side and protected side are readily identifiable. Do not use materials that leave visible marks in the completed work.

3.3 GLAZING, GENERAL

- A. Use methods approved by testing agencies that listed and labeled fire-resistant glazing products.
- B. 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.
- C. 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.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. 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.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. 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.
- H. Set glass lites with proper orientation so that coatings face fire side or protected side as specified.
- I. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- J. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. 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.
- D. 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.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. 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.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. 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.
- C. Installation with Drive-in Wedge Gaskets: 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.
- D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances. 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.

- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial washaway from glass.

3.7 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. 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 buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Remove and replace glass that is damaged during construction period.
- 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 in writing by glass manufacturer.

3.8 FIRE-PROTECTION-RATED GLAZING SCHEDULE

- A. Glass Type: 60-minute fire-protection-rated glazing with 450 deg F temperature-rise limitation.

END OF SECTION 088813

SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Non-load-bearing steel framing systems for interior partitions.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For embossed steel studs and tracks firestop tracks post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.

- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.
- C. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft.

2.2 FRAMING SYSTEMS

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40, hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C 645. Use either steel studs and tracks or embossed steel studs and tracks.
 - 1. Steel Studs and Tracks:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) CEMCO; California Expanded Metal Products Co.
 - 2) MarinoWARE.
 - 3) MRI Steel Framing, LLC.
 - 4) Phillips Manufacturing Co.
 - 5) SCAFCO Steel Stud Company.
 - 6) Steel Network, Inc. (The).
 - b. Minimum Base-Metal Thickness: 0.0329 inch.
 - c. Depth: As indicated on Drawings.
 - 2. Embossed Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally equivalent to conventional ASTM C 645 steel studs and tracks.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) CEMCO; California Expanded Metal Products Co.
 - 2) ClarkDietrich Building Systems.
 - 3) MarinoWARE.
 - 4) MBA Building Supplies.
 - 5) Phillips Manufacturing Co.
 - 6) SCAFCO Steel Stud Company.
 - 7) Steel Network, Inc. (The).

- b. Minimum Base-Metal Thickness: 0.0190 inch.
- c. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide one of the following:

- 1. Clip System: Clips designed for use in head-of-wall deflection conditions that provide a positive attachment of studs to tracks while allowing 2-inch minimum vertical movement.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) CEMCO; California Expanded Metal Products Co.
 - 2) ClarkDietrich Building Systems.
 - 3) Fire Trak Corp.
 - 4) MarinoWARE.
 - 5) SCAFCO Steel Stud Company.
 - 6) Steel Network, Inc. (The).
 - 7) Super Stud Building Products Inc.
- 2. Single Long-Leg Track System: ASTM C 645 top track with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
- 3. Double-Track System: ASTM C 645 top outer tracks, inside track with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
- 4. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Blazeframe Industries.
 - 2) CEMCO; California Expanded Metal Products Co.
 - 3) ClarkDietrich Building Systems.
 - 4) MarinoWARE.
 - 5) MBA Building Supplies.
 - 6) Metal-Lite.
 - 7) Perfect Wall, Inc.
 - 8) SCAFCO Steel Stud Company.
 - 9) Steel Network, Inc. (The).
 - 10) Telling Industries.

D. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of 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.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Blazeframe Industries.
- b. CEMCO; California Expanded Metal Products Co.
- c. ClarkDietrich Building Systems.
- d. Fire Trak Corp.
- e. MarinoWARE.
- f. Metal-Lite.
- g. Perfect Wall, Inc.
- h. SCAFCO Steel Stud Company.
- i. Steel Network, Inc. (The).

E. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-metal thickness, with minimum 1/2-inch- wide flanges.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. ClarkDietrich Building Systems.
- b. MarinoWARE.
- c. MRI Steel Framing, LLC.
- d. SCAFCO Steel Stud Company.

2. Depth: As indicated on Drawings.

3. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. ClarkDietrich Building Systems.
- b. MarinoWARE.
- c. MRI Steel Framing, LLC.
- d. SCAFCO Steel Stud Company.

2. Minimum Base-Metal Thickness: 0.0179 inch.

3. Depth: As indicated on Drawings.

G. Resilient Furring Channels: 1/2-inch- deep, steel sheet members designed to reduce sound transmission.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. ClarkDietrich Building Systems.
- b. MarinoWARE.

- c. MRI Steel Framing, LLC.
- d. SCAFCO Steel Stud Company.

2. Configuration: Asymmetrical or hat shaped.

H. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.

- 1. Depth: 3/4 inch unless indicated otherwise.
- 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
- 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch-diameter wire.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

- 1. Fasteners for Steel 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 of the Work.

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

3.2 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

- 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.3 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks 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 that penetrate 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 track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure, or provide diagonal bracing to underside of structure above at each jamb location.
 - 3. 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.
 - 4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- E. Direct Furring:
 - 1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- 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 092216

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Interior gypsum board.

- B. Related Requirements:

- 1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

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

- B. Samples: For the following products:

- 1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.

1.4 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.

1.5 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. 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

- A. Gypsum Wallboard: ASTM C 1396/C 1396M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum.
 - b. CertainTeed Corporation.
 - c. Georgia-Pacific Gypsum LLC.
 - d. National Gypsum Company.
 - e. USG Corporation.
 2. Thickness: 1/2 inch and 5/8" as indicated.
 3. Long Edges: Tapered.

- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Gypsum.
 - b. CertainTeed Corporation.

- c. Georgia-Pacific Gypsum LLC.
- d. National Gypsum Company.
- e. USG Corporation.

2. Thickness: 5/8 inch.
3. Long Edges: Tapered.

2.4 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. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. L-Bead: L-shaped; exposed long flange receives joint compound.
 - d. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - e. Expansion (control) joint.
- B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Fry Reglet Corporation.
 - b. Gordon, Inc.
 - c. Pittcon Industries.
 2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
 3. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.5 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
 1. Interior Gypsum Board: Paper.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, 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 drying-type, all-purpose compound.

2.6 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Sound-Attenuation Blankets: "Comfortbatt" by Rockwool US; ASTM C 665, Type I (blankets without membrane facing) produced from mineral wool fiber.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- D. Sound-Deadening Board: Semi-rigid wall sheathing panels with sound-deadening STC characteristics; 48" x 84" x 5/8" thick.
- E. Acoustical 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 following:
 - a. Accumetric LLC.
 - b. Franklin International.
 - c. Grabber Construction Products.
 - d. Hilti, Inc..
 - e. Pecora Corporation.
 - f. Specified Technologies, Inc..
 - g. United States Gypsum Company.

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 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.
- C. 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.
- D. Form control and expansion joints with space between edges of adjoining gypsum panels.
- E. 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. (0.7 sq. m) in area.
 2. Fit gypsum panels around ducts, pipes, and conduits.
 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- F. 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.
- G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

- H. 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.
- I. Install sound attenuation blankets and sound-deadening board panels 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. Type X: Where required for fire-resistance-rated assembly.
- 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 vertically (parallel to framing) or horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - 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.

3.4 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.
 - 2. LC-Bead: Use at exposed panel edges.
 - 3. L-Bead: Use where indicated.
 - 4. U-Bead: Use at exposed panel edges and where indicated.
 - 5. Curved-Edge Cornerbead: Use at curved openings.

3.5 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. 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."

3.6 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 095123 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Acoustical tiles for interior ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
- C. Samples for Initial Selection: For components with factory-applied finishes.
- D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
 - 1. Acoustical Tiles: Set of full-size Samples of each type, color, pattern, and texture.
 - 2. Exposed Moldings and Trim: Set of 6-inch- long Samples of each type and color.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Units: One full carton of each type of tile.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical tiles, suspension-system components, and accessories to Project site 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 tiles, permit them to reach room temperature and a stabilized moisture content.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations:

1. Suspended Acoustical Tile Ceilings: Obtain each type of acoustical ceiling tile and its suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. 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: Class A according to ASTM E 1264.
2. Smoke-Developed Index: 50 or less.

2.3 ACOUSTICAL TILES (SAT-A)

- A. Manufacturer (No Substitutions):
 - 1. Certainteed Architectural – Saint Goban.
- B. Acoustical Tile: SYMPHONY m HIGH NRC.
- C. Edge Profile: Reveal #1222-85-1
- D. Size: 24" x 24" x 7/8".
- E. Color: White.
- F. Ceiling Attenuation Class (CAC): Not less than 35.
- G. Noise Reduction Coefficient (NRC): Not less than 0.85.
- H. Antimicrobial Treatment: Manufacturer's standard broad spectrum, 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, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.

ACOUSTICAL TILES (E/R)

- I. Manufacturer (No Substitutions):
 - 1. Certainteed Architectural – Saint Goban.
- J. Acoustical Tile: SYMPHONY f 1342B-IOF-1
- K. Edge Profile: Reveal
- L. Size: 24" x 24" x 1".
- M. Color: White.

2.4 METAL SUSPENSION SYSTEM

- A. Manufacturers: Provide products by the following:
 - 1. Armstrong World Industries, Inc.
 - 2. Certainteed Architectural – Saint Goban.
- B. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation.
 - 1. Structural Classification: Intermediate-duty system.

2. Profile: Prelude ML 15/16" Exposed Tee System (Armstrong).
3. Profile: Reveal Corner Bevel 15/16" EZ Stab Classic – (Certainteed).
4. Finish: White

2.5 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated.
 1. 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.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
 3. Size: Wire diameter sufficient for 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 not less than 0.106-inch-diameter wire.
- C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- 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.

2.6 METAL EDGE MOLDINGS AND TRIM

- A. Manufacturers: Provide products by the following:
 1. Armstrong World Industries, Inc.
 2. Certainteed Architectural – Saint Goban.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations; formed from sheet metal of same material, finish, and color as that used for of suspension-system runners.

1. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
2. Finish: White.

2.7 ACOUSTICAL SEALANT

- A. Acoustical Sealant: As specified in Section 079219 "Acoustical Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine acoustical tiles before installation. Reject acoustical tiles 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 tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. Install suspended acoustical tile ceilings according to ASTM C 636/C 636M and manufacturer's written instructions.
- 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 to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, 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 to structure 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.

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 tiles.

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. 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. Arrange directionally patterned acoustical tiles as follows:

1. As indicated on reflected ceiling plans.

G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges of tiles so tile-to-tile joints are interlocked.

1. Fit adjoining tiles to form flush, tight joints. Scribe and cut tiles for accurate fit at borders and around penetrations through ceiling.

3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 ADJUSTING

- A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095123

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 1. Vinyl base.
 2. Vinyl molding accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.
- C. Samples for Initial Selection: For each type of product indicated.
- D. Product Schedule: For resilient base and accessory products.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 VINYL BASE

- A. Manufacturers: (No Substitutions)
 - 1. Johnsonite; a Tarkett company.
- B. Product Standard: ASTM F 1861, Type TV (vinyl, thermoplastic).
 - 1. Group: I (solid, homogeneous).
 - 2. Style and Location:
 - a. Cove (VCB) as indicated on the Drawings.
- C. Minimum Thickness: 0.125 inch.
- D. Height: 4 inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Preformed.
- G. Inside Corners: Preformed.
- H. Color: "WETLANDS"

2.2 VINYL MOLDING ACCESSORY (VB-1)

- A. Manufacturers: Basis of Design:
 - 1. Johnsonite; a Tarkett company.

- B. Description: Vinyl carpet edge for glue-down applications, nosing for carpet, nosing for resilient floor covering, reducer strip for resilient floor covering, joiner for tile and carpet, and transition strips.
- C. Profile and Dimensions: As indicated.
- D. Locations: Provide vinyl molding accessories in areas indicated.
- E. Colors and Patterns: "WETLANDS".

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 1. Remove adhesive and other blemishes from surfaces.
 2. Sweep and vacuum horizontal surfaces thoroughly.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

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END OF SECTION 096513

SECTION 096810 – CARPET TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes modular carpet tile.
- B. Related Requirements:
 - 1. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
 - a. Review delivery, storage, and handling procedures.
 - b. Review ambient conditions and ventilation procedures.
 - c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
 - 2. Include installation recommendations for each type of substrate.
- B. Shop Drawings: Show the following:
 - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
 - 2. Type of subfloor.
 - 3. Type of installation.
 - 4. Pattern type, location, and direction.
 - 5. Transition details to other flooring materials.

- 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. 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.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Carpet Tile: Minimum of 34 square yards of full-size carpet tile units, type C-1

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with CRI 104.

1.10 FIELD CONDITIONS

- A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
- 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.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.11 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE (C-1)

- A. Product: (No substitutions)
 - 1. Carpet Tile: WORLD WOVEN TWO by Interface
 - a. Color: 105382 "DALE WEAVE"
 - b. Size: 25cm X 1m
 - c. Backing System: GlasBac Tile
 - d. Yarn Manufacturer: Aquafil
 - e. Yarn System: 100% Recycled Content Type 6 Nylon
 - f. Color System: 100% Solution Dyed
 - g. Construction: Tufted Pattern Loop
 - h. Lifetime Antimicrobial: Intercept
 - i. Sil/Stain Protection: Protekt
 - j. Pile Thickness: 0.116 in., 2.9mm
 - k. Pile Density: 9,310
 - l. Total Recycled Content: 65%
 - m. Indoor Air Quality: CRI Green Label Plus #GLP0820
 - n. Installation Method: Ashlar

2.2 CARPET TILE – (C-E/R) OWNER'S EXISTING ATTIC STOCK

- A. Manufacturer: Owner's existing maintenance stock as required in areas as indicated.

2.3 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

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 Section 033000 "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. 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: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
- C. 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.
- D. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- E. 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.

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, "Protecting 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 096810

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 1. Steel and iron.
 2. Galvanized metal.
 3. Wood/Composite Cellular PVC
 4. Gypsum board.
- B. Related Requirements:
 1. Section 055000 "Metal Fabrications" for shop priming metal fabrications.

1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: Provide 1 gal. of each material and color applied.

1.6 QUALITY ASSURANCE

- A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Architect will select one surface to represent surfaces and conditions for application of each paint system.
 - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
 - b. Other Items: Architect will designate items or areas required.
 - 2. Final approval of color selections will be based on mockups.
 - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Basis of Design:
 1. Sherwin Williams Co.
- B. Products: Subject to compliance with requirements, provide one of the products listed in the Interior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."
- B. Material Compatibility:
 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

- C. Colors: Match Architect's samples.
 - 1. Ten percent of surface area will be painted with deep tones.

2.3 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Wood: 15 percent.
 - 2. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- G. Wood/Composite Cellular PVC 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 and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

- 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.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in occupied spaces:
 - a. Equipment, including panelboards.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 - h. Other items as directed by Architect.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. Steel Substrates:
 - 1. Alkyd System MPI INT 5.1E:
 - a. Prime Coat: Primer, alkyd, quick dry, for metal, MPI #76.
 - b. Prime Coat: Shop primer specified in Section where substrate is specified.
 - c. Intermediate Coat: Alkyd, interior, matching topcoat.
 - d. Topcoat: Alkyd, interior, semi-gloss (MPI Gloss Level 5), MPI #47.
- B. Galvanized-Metal Substrates:
 - 1. Alkyd over Cementitious Primer System MPI INT 5.3C:
 - a. Prime Coat: Primer, galvanized, cementitious, MPI #26.
 - b. Intermediate Coat: Alkyd, interior, matching topcoat.
 - c. Topcoat: Alkyd, interior, semi-gloss (MPI Gloss Level 5), MPI #47.
- C. Wood/Composite Cellular PVC Substrates: Trim (where indicated to receive opaque finish)
 - 1. Latex over Latex Primer System MPI INT 6.3T:
 - a. Prime Coat: Primer, latex, for interior wood, MPI #39.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, semi-gloss.
- D. Gypsum Board Substrates:
 - 1. Latex over Latex Sealer System MPI INT 9.2A:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, satin/eggshell (MPI Gloss Level 3), MPI #52.

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END OF SECTION 099123

SECTION 099300 - STAINING AND TRANSPARENT FINISHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and application of wood stains and transparent finishes on the following substrates:
 - 1. Interior Substrates:
 - a. Hardwood trim.

1.3 DEFINITIONS

- A. MPI Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- C. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- D. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- E. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
 - 2. Indicate VOC content.
- B. Samples for Initial Selection: For each type of product.
- C. Samples for Verification: For each type of finish system and in each color and gloss of finish required.

1. Submit Samples on representative samples of actual wood substrates, 8 inches.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.

D. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Stains and Transparent Finishes: Provide 1 gal. of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply finishes when relative humidity exceeds 85 percent, at temperatures less than 5 deg F above the dew point, or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide only the following:

1. Benjamin Moore & Co.
2. Sherwin Williams Co.
3. PPG, Inc.

B. Products: Subject to compliance with requirements, provide one of the products listed in wood finish systems schedules for the product category indicated.

2.2 MATERIALS, GENERAL

- A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, products shall be recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Interior Wood Substrates: 15 percent, when measured with an electronic moisture meter.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with finish application only after unsatisfactory conditions have been corrected.
 - 1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
 - 1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.

1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

D. Interior Wood Substrates:

1. Apply wood filler paste to open-grain woods, as defined in "MPI Architectural Painting Specification Manual," to produce smooth, glasslike finish.
2. Sand surfaces exposed to view and dust off.
3. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dry.

3.3 APPLICATION

A. Apply finishes according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for finish and substrate indicated.
2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

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 finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 INTERIOR WOOD -FINISH-SYSTEM SCHEDULE

A. Wood Substrates: Wood trim.

1. Polyurethane Varnish System MPI INT 6.3K:
 - a. Prime Coat: Polyurethane varnish matching topcoat.
 - b. Intermediate Coat: Polyurethane varnish matching topcoat.
 - c. Topcoat: Varnish, interior, polyurethane, oil modified, satin (MPI Gloss Level 4), MPI #57.

END OF SECTION 099300

SECTION 113100 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Refrigeration appliances provided and installed by the Contractor.

1.3 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
- B. Product Schedule: For appliances.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of appliance.
- C. Sample Warranties: For manufacturers' special warranties for a minimum of five (5) years for each appliance.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Accessibility: Where residential appliances are indicated to comply with accessibility requirements, comply with applicable provisions in the DOJ's 2010 ADA Standards for Accessible Design and ICC A117.1.

2.2 REFRIGERATORS

A. Under-Counter Refrigerator:

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. Amana; a division of Whirlpool Corporation.
 - b. Dacor, Inc..
 - c. Electrolux Home Products (Frigidaire).
 - d. Fisher & Paykel Appliances Limited.
 - e. General Electric Company (GE Appliances).
 - f. Jenn-Air; a division of Whirlpool Corporation.
 - g. KitchenAid; a division of Whirlpool Corporation.
 - h. LG Electronics.
 - i. Maytag; a division of Whirlpool Corporation.
 - j. Miele, Inc..
 - k. Samsung.
 - l. Whirlpool Corporation.
2. Type: Freestanding.
3. Width: 23 inches.
4. Depth: 24 inches.
5. Height: 32" to top of case.
6. Capacity: 3.2 cubic feet minimum.

7. Number of doors: 1.
8. Number of shelves: 3.
9. Door Style: Solid panel
10. Energy Star Certified.
11. Finish: Stainless Steel.

2.3 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical 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, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install appliances according to manufacturer's written instructions.
- B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and that rough openings are completely concealed.
- C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

END OF SECTION 113100

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Solid surface material countertops with integral sink.
2. Solid surface material backsplashes.
3. Solid surface material end splashes.
4. Solid surface material apron fronts.

- B. Related Requirements:

1. Section 224100 "Residential Plumbing Fixtures" for plumbing fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials.

- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

- C. Samples for Initial Selection: For each type of material exposed to view.

- D. Samples for Verification: For the following products:

1. Countertop material, 6 inches square.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of countertops.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.8 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Avonite Surfaces.
- b. Formica Corporation.
- c. LG Chemical, Ltd.
- d. Swan Corporation (The).
- e. Wilsonart LLC.

2. Type: Provide Standard type unless Special Purpose type is indicated.

3. Colors and Patterns: As selected by Architect from manufacturer's full range for all groups.

B. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.

C. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 COUNTERTOP FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Grade: Custom.

B. Configuration:

1. Front: Straight, slightly eased at top
2. Backsplash: Straight, slightly eased at corner.
3. End Splash: Matching backsplash.

C. Countertops: 3/4-inch- thick, solid surface material with integral sink and front edge built up with same material.

D. Backsplashes: 3/4-inch- thick, solid surface material.

E. Fabricate tops with shop-applied edges unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.

F. Joints: Fabricate countertops in sections for joining in field.

1. Joint Locations: Not within 18 inches of a sink or cooktop and not where a countertop section less than 36 inches long would result, unless unavoidable.
2. Splined Joints: Accurately cut kerfs in edges at joints for insertion of metal splines to maintain alignment of surfaces at joints. Make width of cuts slightly more than thickness of splines to provide snug fit. Provide at least three splines in each joint.

G. Cutouts and Holes:

1. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.
2. Fittings: Drill countertops in shop for plumbing fittings and similar items.

2.3 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.
- B. Fasten countertops by screwing through support brackets into underside of countertop at locations indicated. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop.
- C. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- D. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- E. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Predrill holes for screws as recommended by manufacturer.
- F. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
- G. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to Section 230700 for plumbing insulation.

END OF SECTION 220700

SECTION 220800 - COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes commissioning process requirements for Plumbing systems, assemblies, and equipment.
- B. Related Sections:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. Plumbing Systems: Sanitary waste and vent system, service potable water, domestic hot water systems, and domestic water pumping systems.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 INFORMATIONAL SUBMITTALS

- A. Prefunctional Checklists of readiness.
- B. Prefunctional Checklists of completion of installation, prestart, and startup activities.

1.4 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase coordination meetings.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in Plumbing systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.5 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual Plumbing systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.6 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Plumbing systems, assemblies, equipment, and components to be verified and tested.
 4. Prefunctional Checklists certifying that installation, prestart checks, and startup procedures have been completed.
 5. Prefunctional Checklists certifying that Plumbing systems, subsystems, equipment, and associated controls are ready for testing.
 6. Test and inspection reports and certificates.
 7. Corrective action documents.
 8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that Plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that Plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of Plumbing systems at the direction of the CxA.
 - 1. Failure of an item includes a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report.
 - 2. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Plumbing testing shall include entire Plumbing installation, from service hot water systems through distribution systems to all fixtures. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA in cooperation with the Plumbing Contractor, testing and balancing Contractor, and Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 PLUMBING SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

- A. Plumbing Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 22 Sections with references for interconnections to Section 230900 "Instrumentation and Control for HVAC." Assist the CxA with preparation of testing plans.
- B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 22 piping Sections. Plumbing Contractor shall prepare a pipe system

cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
2. Description of equipment for flushing operations.
3. Minimum flushing water velocity.
4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

C. Plumbing Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of service water distribution systems, fuel gas systems, and other distribution systems, including Plumbing equipment and fixtures.

D. Plumbing systems are shown on the contract drawings.

END OF SECTION 220800

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section: "Common Work Results"

1.2 SUMMARY

- A. This Section includes domestic water piping and specialties.

1.3 ACTION SUBMITTALS

- A. Product Data: For domestic water piping, fittings, valves and accessories.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with the local building and plumbing codes.
- C. Qualify brazing processes for copper and copper alloy pipe and tube according to ANSI/AWS C3.4.
- D. Comply with NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances" and NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for combined fire-protection and domestic water service piping to building.
- E. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."
- F. Comply with NSF 372 for low lead.

PART 2 - PRODUCTS

2.1 COPPER TUBING

- A. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
 - 4. Copper-Tubing, Keyed Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.
- B. Mechanically formed copper tee connections are not acceptable.
- C. Viega Pro Press Fittings: Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect) feature design (leakage path). The Smart Connect Feature shall assure leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed connection. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.

2.2 STAINLESS-STEEL PIPING

- A. Potable-water piping and components shall comply with NSF 61 Annex G.
- B. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 10 and Schedule 40.
- C. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.

2.3 VALVES & STRAINERS

- A. Ball Valves
 - 1. The valve body and adapter shall be constructed using Lead Free brass. Lead Free ball valves shall comply with state codes and standards, where applicable, requiring reduced lead content.

2. $\frac{1}{2}$ " to 2" ball valves: 2-piece full port lead-free brass ball valves: The valve must have a blowout proof pressure retaining 316 stainless steel stem, 316 stainless steel ball, virgin PTFE seats, seals, stem packing seal and thrust washer. Valve must have adjustable packing. Valves with O-ring stem seal only are not acceptable. Pressure rating no less than 600psi WOG non-shock, 150psi WSP. Valve shall be manufactured to the MSS-SP-110 standard and shall be a Watts Series LFB6080 (threaded) or LFB6081 (solder).
3. Valve sizes 2-1/2" to 4" threaded, shall be rated to 400psi WOG non-shock and 125psi WSP. Valve sizes 2-1/2" to 3" solder shall be rated to 400psi WOG non-shock and 125psi WSP. Valve shall be a Watts Series LFFBV-3C (threaded) or LFFBVS-3C (solder).
4. Provide locking handle where indicated.
5. Comply with MSS SP-110.

B. Swing check valves:

1. Construct pressure containing parts of Valves as follows: Bronze Valves: 125 or 150 psi: ANSI/ASTM B 62; Iron Body Valves: ANSI/ASTM A-126, Grade B.
2. Check valves shall be lead free.
3. Comply with the following standards for design, workmanship, material and testing: Bronze Valves: MSS SP – 80; Cast Iron Valves: MSS SP – 71
4. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
5. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc.
6. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc.
7. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc.

C. Y-type strainer (3" and smaller) Wye-pattern Lead Free Bronze (cast copper silicon alloy strainer) shall be domestically manufactured and conform to Buy American Act standards. The strainer must have a solid retainer cap with gasket. Strainer shall be rated to 400psi (27.6 bar) WOG @ 210°F; 125psi WSP @ 353°F for sizes 1/4"- 3". The strainer screen shall be 304 stainless steel, 30 mesh. Strainer shall be a Watts Series LF777 (threaded ends) or LFS777 (solder ends).

D. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: match piping.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.4 THERMOSTATIC WATER MIXING VALVES

- A. Manufacturers:
 - 1. Armstrong International, Inc.
 - 2. Lawler Manufacturing Company, Inc.
 - 3. Leonard Valve Company.
 - 4. Powers
 - 5. Symmons Industries, Inc.
- B. To prevent scalding, an ASSE-1070 TMV shall be provided for hand wash sinks, lavatories, and bathtubs. A separate TMV is not required if a code-compliant TMV is built-in to the faucet. Set at 110°F. Install as close as practical to the point of use.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn Industries, LLC; Wilkins; Model ZW3870XLT (Lead-Free) or Model ZW1070XL (Lead-Free).
 - 2. Standard: ASSE 1070, thermostatically controlled, water tempering valve.
 - 3. Pressure Rating: 125 psig.
 - 4. Body: Bronze body with corrosion-resistant interior components.
 - 5. Temperature Control: Adjustable 95-115°F
 - 6. Inlets and Outlet: Threaded.
 - 7. Finish: Rough or chrome-plated bronze.
 - 8. Tempered-Water Design Flow Rate: 0.35 GPM minimum.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Pressure Rating: Provide components having a pressure rating equal to or greater than the system operating pressure.
- B. Mechanically formed tee-branch outlets and brazed joints shall not be used.
- C. Aboveground Domestic Water or Non-Potable Water Piping: Use the following piping materials for each size range:
 - 1. NPS 1 and Smaller: Type L copper.

3.2 VALVES

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty: Use bronze ball valves for piping NPS 3 and smaller.

2. Throttling Duty: Use bronze ball or globe valves for piping NPS 3 and smaller.
- B. Provide sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment.
- C. Provide shutoff valve on each water supply to equipment and specialties. Provide shutoff valve on each water supply to plumbing fixtures without supply stops.
- D. Provide shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside building at each domestic water service.

3.3 PIPING & SPECIALTIES INSTALLATION

- A. Refer to Division 23 Section "Common Work Results" for installation of:
 1. Basic piping requirements.
 2. Joint construction requirements.
 3. Hanger, support, and anchor devices.
 4. Firestopping
 5. Sleeves and Escutcheons
 6. Wall penetration system at each service pipe penetration through foundation wall.
 7. Dielectric fittings
 8. Valves
 9. Mechanical Identification
- B. Provide aboveground domestic water piping level and plumb, free of sags, kinks, and bends.
- C. Provide piping with no dead legs, all sections shall see water flow.
- D. Swing Connections for Expansion: Connect hot water risers and branch connections to mains with at least five pipe fittings, including tee in main.
- E. Provide air vents at piping high points. Include ball valve in inlet.
- F. Water hammer arrestors shall be installed at flush valve water closets, as shown on the plans, and as recommended by Plumbing & Drainage Institute Standard PDI-WH-201. Locate units at the end of branch lines, between the last two fixtures served. Size units based on fixture unit total of branch. All branch pipes serving flush valve water closets shall have water hammer arrestors.
- G. Mixing Valves
 1. An ASSE-1017 DMV shall be provided for the main domestic hot water distribution loop (water stored at 140°F) to reduce water temperature as shown on the construction drawings; the blended water temperature shall be high enough to maintain a minimum of 120°F throughout the distribution system, to the point of use, and in the return pipe to the water heater.

2. To prevent scalding, an ASSE-1070 TMV shall be provided for hand wash sinks, lavatories, and bathtubs. A separate TMV is not required if a code-compliant TMV is built-in to the faucet. Set at 110°F. Install as close as practical to the point of use.

3.4 FIELD QUALITY CONTROL

- A. Provide and test all systems per local code requirements.
- B. Perform the following steps before operation:
 1. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. Close drain valves, hydrants, and hose bibbs.
 3. Open shutoff valves to fully open position.
 4. Open throttling valves to proper setting.
 5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
- C. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.
- D. Check plumbing specialties and verify proper settings, adjustments, and operation.
- E. Inspect domestic water piping as follows:
 1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- F. Test domestic water piping 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 domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

G. Test plumbing specialties according to authorities having jurisdiction and the device's reference standard. Domestic water piping specialties will be considered defective if they do not pass tests and inspections. Prepare test and inspection reports.

H. Adjust each backflow preventer in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.5 CLEANING

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses. Clean and disinfect domestic water piping per code requirements or administrative authority requirements. Sample procedure as indicated:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following: 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. Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION 221116

SECTION 221316 – PLUMBING SANITARY AND STORM PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 22 Section: “Common Work Results”

1.2 SUMMARY

- A. This Section includes piping and specialties.
 - 1. Drainage and vent piping.
 - 2. HVAC condensate waste piping.
- B. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.
- C. General layout shown, provide piping to fixtures as required by the local plumbing code. A licensed master plumber shall perform or supervise the work and provide layouts, piping, and fittings as required by code.

1.3 PERFORMANCE REQUIREMENTS

- A. Comply with the utility requirements for the connection of to the municipal utility services. Obtain and pay for all necessary permits from the applicable municipal department. Obtain authority to connect to their existing mains.
- B. Provide components and installation capable of producing piping systems with working-pressure ratings per local plumbing code.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections.

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with the local building and plumbing codes.

PART 2 - PRODUCTS

2.1 CAST-IRON SOIL PIPING

A. Hubless

1. Hubless Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A-888 and CISPI Standard 301. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute.
2. Hubless couplings shall conform to ASTM C-1540 heavy duty couplings.
3. Gaskets shall conform to ASTM C-564. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and local code requirements.
4. Couplings shall be installed in accordance with the manufacturer's band tightening sequence and torque. Tighten bands with a properly calibrated torque limiting device.

B. Hub and Spigot Cast Iron Soil Pipe and Fittings:

1. Hub and Spigot Cast Iron pipe and fittings shall be manufactured from gray cast iron and shall conform to ASTM A-74. All pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute. Pipe and fittings to be Extra Heavy (XH).
2. Joints can be made using a compression gasket manufactured from a neoprene elastomer meeting the requirements of ASTM C-1563 or lead and oakum. All pipe and fittings to be produced by a single manufacturer and are to be installed in accordance with manufacturer's recommendations and local code requirements. The system shall be hydrostatically tested after installation to 10 ft. of head (4.3 psi maximum).

2.2 PVC DRAINAGE PIPING

A. Pipe and fittings shall be manufactured from PVC compound with a cell class of 12454 per ASTM D-1784 and conform with National Sanitation Foundation (NSF) standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM D-1785 and ASTM D-2665. Fittings shall conform to ASTM D-2665.

- B. All pipe and fittings to be produced by a single manufacturer and to be installed in accordance with manufacturer's recommendations and local code requirements. Solvent cements shall conform to ASTM D-2564, primer shall conform to ASTM F-656. The system to be manufactured by Charlotte Pipe and Foundry Co. or approved equal; and shall be intended for non-pressure drainage applications where the temperature will not exceed 140°F.
- C. Solvent cement joints for PVC pipe and fittings shall be clean from dirt and moisture. Pipe shall be cut square and pipe shall be deburred. Where surfaces to be joined are cleaned and free of dirt, moisture, oil and other foreign material, apply primer in accordance with ASTM F656.

2.3 COPPER TUBE AND FITTINGS

- A. Copper Type 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, water tube, drawn temper.
- D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
- E. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.4 CLEANOUTS

- A. Manufacturers
 - 1. Zurn
 - 2. Smith, Jay R. Mfg. Co.
 - 3. Josam Co.
 - 4. Tyler Pipe, Wade Div.
 - 5. Watts Industries, Inc., Drainage Products Div.
 - 6. Mifab
 - 7. Wade
- B. Provide per plumbing code.
- C. Cleanouts shall be easily accessible and shall be gastight and watertight. Provide a minimum clearance of 24 inches for the rodding. Size of cleanout shall be same as pipe size through 4". Pipes 4" and larger shall have 4" cleanouts.
- D. Basis of Design Watts CO-200-R
 - 1. Compliance: ANSI/ASME A112.36.2M.
 - 2. Load Rating: MD - Safe Live Load 2,000-4,999 lbs.
 - 3. Epoxy coated cast iron floor cleanout with 5" round adjustable gasketed nickel bronze top, removable gas tight gasketed brass cleanout plug, and no hub (standard) outlet.

4. When a waterproof membrane is used in the floor system, provide clamping collars on the cleanouts.
5. In carpeted areas, provide carpet cleanout markers.
6. Round, square, or recessed for tile tops as required.
7. Provide vandal secured top when scheduled.

E. Cleanouts shall consist of "Y" fittings and (1/8 inch) bends with brass or bronze screw plugs.

F. Provide cleanouts at or near the base of the vertical stacks with the cleanout plug located approximately 24 inches above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack. Cleanout shall consist of sanitary tees. Extend the cleanouts to the wall access cover; Zurn 1400 Series.

G. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.
- A. Aboveground Soil, Waste, and Vent Piping: Use PVC or cast iron.

3.2 PIPING INSTALLATION

- A. Refer to Division 23 Section "Common Work Results" for installation of:
 1. Basic piping requirements.
 2. Joint construction requirements.
 3. Hanger, support, and anchor devices.
 4. Firestopping
 5. Sleeves and Escutcheons
 6. Wall penetration system at each service pipe penetration through foundation wall.
 7. Dielectric fittings
 8. Valves
 9. Mechanical Identification
- B. Provide 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. Make joints according to CISPI.
 2. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.

3. Hubless Joints: Make with rubber gasket and sleeve or clamp.
- C. Provide PVC soil and waste drainage and vent piping according to ASTM D 2665.
- D. Provide underground PVC soil and waste drainage piping according to ASTM D 2321.
- E. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling. Aboveground Pressure Piping: Pipe fitting.
- F. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve; ends same size as piping to be joined, and corrosion-resistant metal band on each end.
- G. Make changes in direction for 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 2 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.
- H. Provide drainage piping beginning at low point of each system. Provide true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Provide 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.
- I. Provide drainage and vent piping at the minimum slopes as required by the local plumbing code.

3.3 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior drainage piping to exterior drainage piping.
- C. Connect drainage and vent piping to fixtures and equipment as shown on the plans.
- D. Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
- E. Provide traps on plumbing specialty drain outlets.
- F. Provide expansion joints on vertical risers, stacks, and conductors as required by code.

G. Cleanouts:

1. Provide cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated: Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated. Locate at each change in direction of piping greater than 45 degrees. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping. Locate at base of each vertical soil and waste stack.
2. Provide cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.
3. Provide cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
4. Provide flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

3.4 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours 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. Test 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 piping 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 w.g. 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.

- C. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
- D. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

3.5 CLEANING

- 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.

END OF SECTION 221316

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results"
 - 2. Division 22 Plumbing Sections

1.2 SUMMARY

- A. This Section includes Plumbing Fixtures.

1.3 SUBMITTALS

- A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- B. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Comply with the local building and plumbing codes.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; about plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

- E. NSF Standard: Comply with NSF 61, "Drinking Water System Components - Health Effects," for fixture materials that will be in contact with potable water.
- F. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Common Plumbing Fixture Requirements
 - 1. Vitreous china, nonabsorbent, hard-burned, and vitrified throughout the body shall be provided. Porcelain enameled ware shall have specially selected, acid-resisting enamel coating evenly applied on surfaces. No fixture will be accepted that shows cracks, crazes, blisters, thin spots, or other flaws. Fixture color shall be white except as specified herein.
 - 2. Provide combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
 - 3. Fixtures shall be provided appurtenances such as traps, supplies, faucets, stop valves, and drain fittings – for a complete, finished, code-compliant installation.
 - 4. Coordinate fixture rough in dimensions for conflicts with surrounding structure, prior to submitting.
 - 5. Each fixture and piece of equipment requiring connections to the drainage system shall be equipped with a trap.
 - 6. Brass expansion or toggle bolts capped with acorn nuts shall be provided for supports, and polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view.
 - 7. Fixture supports for off-the-floor fixtures shall be of the chair-carrier type. The carrier shall provide the necessary means of mounting the fixture, with a foot or feet to anchor the assembly to the floor slab. Adjustability shall be provided to locate the fixture at the desired height and in proper relation to the wall. Support plates, in lieu of chair carrier, shall be fastened to the wall structure only where it is not possible to anchor a floor-mounted chair carrier to the floor slab. Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.
 - 8. Provide access panels to concealed valves and components. All components shall have proper access in accordance with manufacturers' recommendations.
 - 9. Mounting heights: Refer to Architectural Plans.
 - 10. Water line components shall be lead-free.

2.2 LAVATORIES

- A. **P-1:** Integral with counter, coordinate with casework supplier. Provide 304SS grid drain.
- B. Lavatory Faucets:

1. See faucet specifications in paragraphs hereinafter.
2. ADA lever handles

2.3 LAVATORY AND SINK FAUCETS

A. Faucet Manufacturers

1. Moen
2. Symmons
3. Delta Commercial
4. Chicago
5. Gerber
6. Zurn
7. Kohler
8. American Standard

B. Faucets - Common Requirements:

1. Comply with ASME A112.18.1M, NSF372-2011, ADA; UL 1951
2. Body Material: Commercial, solid cast brass.
3. Lead Free: Faucet contains $\leq 0.25\%$ total lead content by weighted average
4. Thermostatic mixing valves (TMV), as indicated: 20" flexible stainless steel inlet hoses with 3/8" compression fittings. ASSE 1070 certified down to 0.35 GPM
5. Provide antimicrobial handles: Chicago Sureshield® Technology, or equal; In a 28-day dried film fungal test (ASTM G 21-96), the untreated sample shows significant fungal growth, while the Sureshield sample remains virtually unchanged.

C. **P-1:** ADA lever handles: American Standard Model #7545; 4" centerset, vandal-resistant handles; Gooseneck swivel spout with swing limited to 140°; vandal-resistant 0.5 GPM pressure compensating aerator; 1/4-turn washer-less ceramic disc valve cartridges. Provide a TMV as specified.



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 fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION - GENERAL

- A. Assemble and support fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Provide fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- C. Provide water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Provide stops in locations where they can be easily reached for operation.
- D. Provide traps on fixture outlets as required.
 1. Provide level and plumb according to roughing-in drawings.
- E. Provide supports and connections to fixtures per manufacturer's instructions.
- F. Provide escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.
- G. Set floor mounted fixtures in a leveling bed of cement grout as per fixture manufacturer's instructions.
- H. Joint Sealing: Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to water-closet color. Comply with sealant requirements specified in Division 9.
- I. Wall Flange and Escutcheon Installation: Provide wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork. Provide deep-pattern escutcheons if required to conceal protruding fittings.

3.3 SINKS

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning lavatories, fittings, and controls. Adjust water pressure at faucets to produce proper flow.

3.4 HOOK UPS

3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.
- C. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

3.6 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed. Check that fixtures are complete with trim, faucets, fittings, and other specified components. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- B. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves. Adjust set point within allowable temperature range.
- D. Operate and adjust fixtures. Replace damaged and malfunctioning fixtures, fittings, and controls.
- E. Adjust water pressure to produce proper flow and stream.
- F. Replace washers and seals of leaking and dripping faucets and stops.

3.7 CLEANING

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

- B. Clean fixtures and other fittings with manufacturers' recommended cleaning methods and materials. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts. Remove sediment and debris from drains.
- C. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

3.8 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless allowed in Division 1.

END OF SECTION 224000

SECTION 230500 – COMMON WORK RESULTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This section applies to Plumbing Division 22 & and HVAC Division 23 sections.

1.2 GENERAL

- A. Section 230500 includes items common to all the division specification sections.
- B. Provide services, skilled and common labor, and all apparatus and materials required for the complete installation as shown and within the intent of the contract documents, field conditions, and code requirements.
- C. The intention of these Contract Documents is to call for finished work, fully tested and ready for operation. Any components or labor not mentioned in the Contract Documents but required for functioning systems shall be provided. Should there appear to be any discrepancies or questions of intent, the Contractor shall refer the matter to the Architect/Engineer for a decision before start of any related work.
- D. Consistency and Completeness: The contract documents are intended to include all components; however, the contract documents may not be perfect. Repetitive, common components (such as volume dampers, thermostats, condensate drains, trap primers, vent pipes, valves, etc.) are shown throughout. If a common component is missing in from the drawings, provide as similar per other areas. There will be no change orders for missing such components, the contractor shall provide consistent, complete, functioning systems.
- E. Should the Drawings or the Specifications disagree in themselves or with each other, the Contractor shall provide the better quality or greater quantity of work and/or materials unless otherwise directed by written addendum to the Contract Documents.
- F. Materials or work described in words, which so applied, have a well-known technical or trade meaning shall be held to refer to such recognized standards. Since the plans and specifications cover the dimensions and features of the work and do not set forth the analysis of the design, it is the duty of the Contractor fulfilling them to ascertain the true intent in any case where it is doubtful.

1.3 MANUFACTURERS INSTRUCTIONS

- A. Provide equipment and components to comply with manufacturer's written installation instructions and published drawings.
- B. Follow manufacturer's instructions for inspection, start-up, calibration, commissioning, and testing.

1.4 DEFINITIONS

- A. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- B. "Provide": Furnish and install, complete and ready for the intended use.
- C. "Shall": The word "shall" is used to indicate mandatory requirements strictly to be followed in order to conform to the standard and procedures and from which no deviation is permitted.
- D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and attics.
- E. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- F. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- G. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- H. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- I. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

1.5 SUBMITTALS

- A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in

individual sections. Shop Drawings shall be dated and contain Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials, and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at one time. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Shop Drawings will be given a general review only.

1.6 SUBSTITUTIONS

A. Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Engineer will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
2. Requested substitution does not require revisions to the Contract Documents.
3. Requested substitution is consistent with the Contract Documents and will produce indicated results.
4. Substitution request is fully documented and properly submitted.
5. Requested substitution will not adversely affect Contractor's Construction Schedule.
6. Requested substitution has received necessary approvals of authorities having jurisdiction.
7. Requested substitution is compatible with other portions of the Work and shall be acceptable to all contractors involved.
8. Equipment electrical characteristics different than scheduled may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified at no additional cost.
9. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
10. Requested substitution has been coordinated with other portions of the Work.
11. Requested substitution provides specified warranty.

1.7 QUALITY ASSURANCE

A. Work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications.

B. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.

- C. Installer Qualifications: Work shall be done by skilled mechanics shall have successfully completed an apprenticeship program or another craft training program.
- D. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.

1.8 COORDINATION

- A. Coordinate use of project space and sequence of installation of work, which is indicated diagrammatically on drawings. Follow routings shown, as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- B. Coordinate use of project space and sequence of installation of work.
- C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Coordinate requirements for access panels and doors for items requiring access that are concealed behind finished surfaces. Access panels shall be provided for any item requiring inspection or maintenance. Access panels shall be of sufficient size and located so that the concealed items may be serviced, maintained, or replaced.
 - 1. Access panels and doors are specified and provided by Division 8.

1.9 TEST ADJUST AND BALANCE READINESS

- A. The Contractor shall provide and coordinate the services of qualified, responsible subcontractors, suppliers and personnel as required to correct, repair, and/or replace deficient items or conditions found during the course of this project, including the testing, adjusting, and balancing period.
- B. In order that systems may be properly tested, balanced, and adjusted as required herein by these Specifications, the Contractor shall operate the systems at his expense for the length of time necessary to properly verify their completion and readiness for TAB. Project Contract completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy. The Contractor shall allow adequate time for the testing and balancing activities of the Owner provided services, during the construction period, and prior to Substantial Completion as defined in the Uniform General Conditions of this Construction Document.
- C. The Drawings and Specifications indicate adjustment devices for the purpose of adjustment to obtain optimum operating conditions, and it will be the responsibility of the Contractor to provide these devices in a manner that will leave them accessible and readily adjustable. Should any such device not be readily accessible, the Contractor shall provide access as requested by

the TAB Firm. Also, any malfunction encountered by TAB personnel and reported to the Contractor shall be corrected by the Contractor immediately so that the balancing work can proceed with the minimum of delays.

D. Complete operational readiness of the HVAC systems also requires that the following be accomplished:

1. Distribution Systems:

- a. Verify installation for conformity to design. Ducts shall be terminated and tested as required by the Specification.
- b. Dampers shall be properly located and functional. Dampers shall have tight closure and open fully with smooth and free operation.
- c. RGD'S and terminal devices shall be provided and secured in a fully open position.
- d. Air handling systems and associated apparatus shall be sealed to eliminate uncontrolled bypass or leakage of air. Clean filters shall be in place, coils shall be clean with fins straightened, bearings properly greased, and the system shall be completely operational. The Contractor shall verify that systems are operating within the design pressure limits of the piping and ductwork.
- e. Under normal operating conditions, check condensate drains for proper connections and functioning. Cooling coil drain pans have a positive slope to drain. Cooling coil condensate drain trap maintains an air seal.
- f. Fans shall be operating and verified for freedom from vibration, proper fan rotation.
- g.
- h. Bearings shall be greased.
- i. Terminal units shall be provided and functional (i.e., controls functioning).

2. Water Circulating Systems:

- a. Verify installation for conformity to design. Hydronic systems are pressure tested, flushed, filled, and properly vented; valves are fully open. Examine HVAC system and equipment installations to verify that indicated balancing devices are properly provided, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation
- b. Valves shall be set to their fully open position. After the system is flushed and checked for proper operation, strainers shall be removed and cleaned. The Contractor shall repeat the operation until circulating water is clean and then the start-up strainers shall be discarded.
- c. Record motor amperage on each phase and voltage after reaching rated speed. Readings shall not exceed nameplate rating. Thermal overload protection is in place.
- d. In preparation of TAB, water circulating systems shall be full and free of air, expansion tanks shall be set for proper water level, and air vents shall be provided at high points of systems and operating freely. Chemicals shall be added to closed systems to treat piping and inhibit corrosion. The system static pressure shall be adequate to completely fill the system without operating the pumps.

- e. Check and set operating parameters of the heat transfer and control devices to the design requirements.
- f. Proper balancing devices shall be in place and located correctly. Heat transfer coils shall be checked for correct piping connections.

3. Building Automation System (BAS)

- a. The BAS Contractor shall verify that control components are provided in accordance with project requirements and are functional.
- b. The BAS Contractor shall verify that controlling instruments are calibrated and set for design operating conditions with the exception of components that require input from the TAB Agency, but a default shall be set. The Control Contractor shall cooperate with the TAB Agency and provide software and interfaces to communicate with the system.
- c. The BAS Contractor shall thoroughly check controls, sensors, operators, sequences, etc. before notifying the TAB Agency that the BAS is operational. The BAS Contractor shall provide technical support (technicians and necessary computers) to the TAB Agency for a complete check of these systems.
- d. Prior to occupancy, each ventilation system shall be tested to ensure that OA dampers operate properly in accordance with system design.
- e. Fire Alarm: Division 26 shall thoroughly check detection devices, sequences, inter-locks, etc. before notifying the TAB Agency that the system is operational. Division 26 shall certify that the systems are totally operational to the Contractor prior to the TAB beginning.

1.10 RENOVATION PROJECT REQUIREMENTS

- A. The Contractor shall cooperate with the Owner to minimize conflicts with the Owner's operations.
- B. The Contractor shall study drawings and specifications, visit the site, and get acquainted with the existing conditions and the requirements of the plans and specifications. No claim will be recognized for extra compensation due to the failure of the Contractor to be familiarized with the conditions and extent of the proposed work. The Contractor shall execute alterations, additions, removals, relocations, or new work, etc., as indicated, or required to provide a complete installation in accordance with the intent of the drawing and specifications.
- C. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of site beyond areas in which the Work is indicated. Keep driveways and entrances serving premises clear and available to Owner. Schedule deliveries to minimize use of driveways and entrances and minimize space and time requirements for storage of materials and equipment on-site.
- D. Follow the recommended procedures of the SMACNA IAQ Guidelines for Occupied Buildings under Construction.
- E. Continuity of Services: The building will be in use during construction operations. Maintain existing systems in operation within rooms of building. Schedules for various phases of

contract work shall be coordinated with other trades and with Owner's Representative. Provide, as part of the contract, temporary plumbing and mechanical and electrical connections and relocations as required to accomplish the above. Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services. Notify Owner at least two days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions. Indicate method of providing temporary utilities. Do not proceed with utility interruptions without Owner's written permission.

F. Cutting And Patching: Provide temporary support of Work to be cut. Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

1. Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.
2. Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
3. Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original installer; comply with original installer's written recommendations.
4. Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing. Clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
5. Any structural member weakened or impaired by cutting, notching, or otherwise shall be reinforced, repaired, or replaced so as to be left in safe structural condition in accordance with the local building code requirements.
6. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
7. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

PART 2 - PRODUCT

2.1 PRODUCT CRITERIA

- A. Any costs incurred due to deviations from basis of design unit shall be responsibility of the contractor.
- B. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 5 years.
- C. Equipment Service: Products shall be supported by a service organization that maintains a complete inventory of repair parts and is located reasonably close to the site.
- D. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
- E. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
- F. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- G. Asbestos products or equipment or materials containing asbestos shall not be used.

2.2 IDENTIFICATION

- A. Equipment:
 - 1. Terminology: Match schedules as closely as possible.
 - 2. Tag and description: Example: "EF-1 - Bathroom Exhaust"
 - 3. Equipment Markers: Custom Vinyl Decals with a clear polyester overlaminate to endure outdoor conditions and are UV and scuff resistant. Decals shall be made of flexible vinyl with a permanent pressure-sensitive adhesive backing suitable for curved surfaces. Service temperature range of -40°F to 176°F.]
 - 4. In addition to the equipment tag, equipment located above the ceiling that requires servicing shall be labeled on the ceiling grid using a labeling machine.
- B. Piping Identification Devices
 - 1. Manufactured Pipe Markers, General: Seton, Brady, or approved equal; preprinted, color-coded, with lettering indicating service, and showing direction of flow.
 - 2. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping. Lettering: Use piping system terms indicated and

abbreviate only as necessary for each application length. Size of letters and length of color field per ASME A13.1.

- 3. Pipes with OD, Including Insulation; Full-band snap-around pipe markers extending 360 degrees around pipe at each location. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow. Length of color field and size of letters shall be proportional to pipe OD.
- 4. Types: Self-adhesive type: Seton Opti-Code; Snap-around type: Seton Setmark; Wrap-around type: Seton Ultra-mark; PVF over-laminated polyester construction seals in and protects graphics; suitable for outdoor or harsh environments.

C. Concealed manual volume dampers shall be visible outside the insulation and marked with 12" orange ribbon.

D. Valve Tags & Schedules

- 1. Valve Tags: Stamped or engraved 1-1/2 round with 1/4-inch letters for piping system legend and 1/2-inch black-filled numbers, with numbering scheme; 3/16" hole for fastener; Material: 19-gauge brass; Valve-Tag Fasteners: Brass wire-link or beaded chain; or S-hook.
- 2. Valve Schedules: For each piping system, on standard-size bond paper. Also save in PDF format. 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. Valve-Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws. Frame: aluminum. Glazing: ASTM C 1036, Type I, Class 1, Glazing Quality B, 2.5-mm, single-thickness glass.

E. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing. Size: 3 by 5-1/4 inches minimum. Large-size primary caption such as "DANGER". Color: Yellow background with black lettering.

2.3 PIPE JOINING MATERIALS

- A. Provide per local code.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- C. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Press Connections

1. Basis-of-Design Product: Subject to compliance with requirements, provide Viega LLC; ProPress, Apollo, or approved equal.
2. Press ends shall have Viega Smart Connect, Apollo Leak Before Press, or similar technology designed into the fitting itself, allowing identification of an un-pressed fitting during pressure testing. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.
3. Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of ASME B16.51 and IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by the fitting manufacturer.
4. Steel: Cold Press Mechanical Joint Fitting shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria ANSI/CSA LC4. Sealing elements for press fittings shall be HNBR. Sealing elements shall be factory installed or an alternative supplied by the fitting manufacturer. Piping and fittings shall comply with CSA LC-4 and local codes.

E. Mechanical Coupling Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents and exterior environment. Gasket design shall be such that the entire coupling housing is isolated from the system contents to prevent galvanic action and inhibit galvanic corrosion.

F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

G. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

H. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

I. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

J. Solvent Cements for Joining Plastic Piping: CPVC Piping: ASTM F 493. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

K. Plastic-to-Metal Transition Fittings: one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657. Plain-End Pipe and Fittings: Use butt fusion. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Provide dielectric isolation at the connection of dissimilar metals. Provide brass ball valves or fittings; or Watts Series LF3000 (lead free) or approved equal.

2.4 SLEEVES & ESCUTCHEONS

- 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 water-stop 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.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Provide wall penetration system where service pipes penetrate through foundation wall or floor. Make installation watertight. Mechanical Sleeve Seals: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve; Thunderline Link-Seal, or approved equal.
 - 1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Glass-reinforced nylon.
 - 3. Connecting Bolts and Nuts: Stainless steel, of length required to secure pressure plates to sealing elements.
- G. Escutcheons shall be manufactured from nonferrous metals and shall be chrome-plated. Metals and finish shall conform to ASME A112.19.2. Escutcheons shall be one-piece type where mounted on chrome-plated pipe or tubing, and one-piece of split-pattern type elsewhere. ID shall closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers the opening. Escutcheons shall have setscrews for maintaining a fixed position against a surface.

2.5 HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-Line Systems, Inc.
 - 2. Carpenter & Patterson, Inc.
 - 3. Grinnell Corp.

4. Hubbard Enterprises/Holdrite
5. National Pipe Hanger Corp.
6. Piping Technology & Products, Inc.
7. Unistrut
8. Anvil International, Inc.
9. Empire

B. Provide in accordance with MSS SP69 - Manufacturers Standardization Society: Pipe Hangers and Supports- Selection and Application. Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped on the part itself for identification.

C. The materials of pipe hanging and supporting elements shall be in accordance with MSS SP-58. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Do not allow dissimilar metals to come into contact.

D. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel." Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications." Comply with provisions in ASME B31 Series, "Code for Pressure Piping." Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

E. Delegated-Design Submittal: For 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. Show fabrication and installation details and include calculations. Provide for the following: trapeze pipe hangers, metal framing systems, pipe stands, equipment supports.

F. Hangers:

1. Uninsulated pipes 2 inch and smaller: Adjustable steel swivel ring (band type) hanger, Type 10, B-Line B3170; Adjustable steel swivel J-hanger, Type 5, B-Line B3690; Malleable iron ring hanger, Type 12, B-Line B3198R or hinged ring hanger, B3198H. Adjustable steel clevis hanger, Type 1, B-Line B3100.
2. Uninsulated pipes 2-1/2 inch and larger: Adjustable steel clevis hanger, Type 1, B-Line B3100.
3. Insulated Hot piping: 2 inch and smaller pipes: use adjustable steel clevis with galvanized sheet metal shield. Type 1, B-Line B3100 with Type 40, B-Line B3151 series insulation protection shield. 2-1/2 inch and larger pipes: Type 41 or Type 43 with Type 39A/39B, B3160-B3165 series pipe covering protection saddle.
4. Insulated Cold piping: use adjustable steel clevis with galvanized sheet metal shield. Type 1, B-Line B3100 with Type 40, B-Line B3151 series insulation protection shield.
5. Copper Tubing Supports Hangers shall be sized to fit copper tubing outside diameters. Adjustable steel swivel ring (band type) hanger, Type 10, B-Line B3170CT. Malleable iron ring hanger, Type 12, B-Line B3198RCT or hinged ring hanger B3198HCT.

Adjustable steel clevis hanger, Type 1, B-Line B3104CT. For supporting copper tube to strut use plastic inserted vibration isolation clamps, B-Line BVT series.

6. Plastic Pipe Supports: V-Bottom clevis hanger with galvanized 18-gauge continuous support channel, Type 1, B-Line B3106 and B3106V plastic pipe support channel, to form a continuous support system for plastic pipe or flexible tubing.

G. Pipe Clamps: When flexibility in the hanger assembly is required due to horizontal movement, use pipe clamps with weldless eye nuts, Type 4, B-Line B3140. For insulated lines use double bolted pipe clamps, Type 3, B-Line B3144.

H. Multiple or Trapeze Hanger: Trapeze hangers shall be constructed from 12-gauge roll formed ASTM A1011 SS Grade 33 structural steel channel, 1-5/8 inch by 1-5/8-inch minimum, B-Line B22 strut or stronger as required. Mount pipes to trapeze with 2-piece pipe straps sized for outside diameter of pipe, B-Line B2000 Series.

I. Wall Supports: Pipes 4" and smaller: Carbon steel J-hanger, B-Line B3690. Pipes larger than 4": Welded strut bracket and pipe straps, Type 31 light welded steel bracket, B-Line B3064. Provide Type 32 or Type 33 for heavier loads.

J. Floor Supports: Hot piping under 6 inch and cold piping: Carbon steel adjustable pipe saddle and nipple attached to steel base stand sized for pipe elevation. Type 38 adjustable pipe saddle, B-Line B3093 and B3088T base stand; or Type 39, B3090 and B3088 base stand. Pipe saddle shall be screwed or welded to appropriate base stand. Hot piping 6 inch and larger: Adjustable Roller stand with base plate, Type 46, B3118SL. Adjustable roller support and steel support sized for elevation, B-Line B3124.

K. Vertical Supports: Steel riser clamp sized to fit OD of pipe, Type 8, B-Line B3373.

L. Supplementary Structural Supports: Design and fabricate supports using structural quality steel bolted framing materials as manufactured by Cooper B-Line. Channels shall be roll formed, 12 gauge ASTM A1011 SS Grade 33 steel, 1-5/8 inch by 1-5/8 inch or greater as required by loading conditions. Submit designs for pipe tunnels, pipe galleries, etc., to engineer for approval. Use clamps and fittings designed for use with the strut system.

M. Beam Clamps shall be used where piping is to be suspended from building steel. Clamp type shall be selected on the basis of load to be supported, and load configuration. C-Clamps shall have locknuts and cup point set screws, Type 23, B-Line B351L. Refer to manufacturer's recommendation for setscrew torque. Retaining straps shall be used to maintain the clamps position on the beam where required.

N. Concrete Inserts: Cast in place spot concrete inserts shall be used where applicable; either steel or malleable iron body, Type 18, B-Line B2500 or B3014. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rod sizes, B-Line N2500 or B3014N series. Continuous concrete inserts shall be used where applicable. Channels shall be 12 gauge, ASTM A1011 SS Grade 33 structural quality carbon steel, complete with Styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a load rating of 2,000 lbs./ft. in concrete, B-Line B22I, 32I, or 52I. Select channel nuts suitable for strut and rod sizes.

O. For air conditioning and other vibrating system applications, use a clamp that has a vibration dampening insert and a nylon inserted locknut. For copper and steel tubing use B-Line BVT-Series Vibraclamps. For larger tubing or piping subjected to vibration, use neoprene or spring hangers as required. For base mounted equipment use vibration pads, molded neoprene mounts, or spring mounts as required.

P. Accessories

1. Hanger Rods shall be threaded both ends, or continuous threaded rods of circular cross section. Use adjusting locknuts at upper attachments and hangers. No wire, chain, or perforated straps are allowed.
2. Shields shall be 180 degree galvanized sheet metal, 12 inch minimum length, 18 gauge minimum thickness, designed to match outside diameter of the insulated pipe, B-Line B3151.
3. Pipe protection saddles shall be formed from carbon steel, 1/8 inch minimum thickness, sized for insulation thickness. Saddles for pipe sizes greater than 12 inch shall have a center support rib.

Q. Indoor Finishes: Hangers and clamps for support of bare copper piping shall be coated with copper colored epoxy paint, B-Line Dura-Copper®. Additional PVC coating of the epoxy painted hanger shall be used where necessary. Hangers for other than bare copper pipe shall be zinc plated in accordance with ASTM B633; or shall have an electro-deposited green epoxy finish, B-Line Dura-Green®. Strut channels shall be pre-galvanized in accordance with ASTM A653 SS Grade 33 G90 OR have an electro-deposited green epoxy finish, B-Line Dura-Green®.

R. Outdoor Finishes: Hangers and strut located outdoors shall be hot dip galvanized after fabrication in accordance with ASTM A123. Hanger hardware shall be hot dip galvanized or stainless steel. Zinc plated hardware is not acceptable for outdoor or corrosive use.

S. Unistrut (MFMA) Manufacturer Metal Framing System:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Unistrut Corporation
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. Thomas & Betts Corporation.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with in-turned lips. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
5. Coating: Unistrut Perma-green or similar.

2.6 THERMOMETERS AND PRESSURE GAUGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ashcroft
 2. Weksler
 3. Ernst Gauge Co.
 4. Trerice: H. O. Trerice Co.
 5. Weiss Instruments, Inc.
- B. The proper range will be selected so that the operating temperature/pressure of the material being measured will fall approximately in the middle of the scale.
- C. Liquid-In-Glass Industrial Thermometers: shall be a blue reading (Fill Type Spirit: Blue colored, organic) liquid-in-glass adjustable angle type, 9" scale, cast aluminum case with cured polyester powder coating, clear acrylic window and brass separable thermowell. Thermometers will be Trerice BX9 Series or approved equal.
- D. Thermowells: Provide fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem. Material shall be compatible with the piping. Where insulation thickness exceeds 2", a longer stem thermometer will be used with an extension neck brass separable thermowell. The extension neck will be at least 2" long. Cap: Threaded, with chain permanently fastened to socket.
- E. Pressure gauges shall be 3½" dial size with a flangeless cast aluminum case, stainless steel friction ring and glass window. The movement will be brass with a bronze bourdon tube and brass socket. The dial face will be white with black figures; pointer will be friction adjustable type. Accuracy shall be ±1% of scale range, ASME B40.1 Grade 1A. Pressure gauges will be Trerice No. 600CB approved equal.
 1. Connector: Brass, NPT 1/4.
 2. Units of Measure: PSI
 3. Provide silicone-damped movement.
 4. Provide pressure-gauge needle valve and snubber (Trerice No. 872 pressure snubbers) in piping to pressure gauges; ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.
 5. Needle Valves: Trerice 735 Series; NPS 1/4 brass or 316 stainless steel needle type.

2.7 MISCELLANEOUS

- A. Grout: ASTM C 1107, Grade B, non-shrink, and nonmetallic, dry hydraulic-cement grout. Characteristics: Post-hardening, volume adjusting, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications. Design Mix: 5000-psi, 28-day compressive strength. Packaging: Premixed and factory packaged.
- B. Equipment shall be vibration isolated to prevent vibration transmission to the building structure.

PART 3 - EXECUTION

3.1 DEMOLITION AND REMOVALS

- A. Refer to Division 1 for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing and mechanical systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and cap and seal remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap and seal ducts with same or compatible ductwork material.
 - 5. Equipment to be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 COMMON REQUIREMENTS

- A. Work shall be conducted, installed, and completed in a neat and professional manner reflecting a minimum level of competent workmanship.
- B. The drawings show the general arrangement of systems and equipment but do not show all required fittings and offsets that may be necessary to connect pipes and ductwork to equipment, and to coordinate with other trades. Provide necessary fittings, offsets and runs based on field measurements and at no additional cost. Coordinate with other trades for space available and relative location of equipment and accessories. Pipe and duct location on the drawings shall be altered by the contractor where necessary to avoid interferences and clearance difficulties.
- C. Fabricate based on field measurements.
- D. Corrections or comments made on the shop or coordination drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for: confirming and correcting quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction;

coordinating his work with that of other trades; and performing work in a safe and satisfactory manner.

- E. Protection and Cleaning: Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items shall be replaced. Protect finished parts of equipment. Close duct and pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water, chemical, or mechanical injury. At completion of work thoroughly clean fixtures, exposed materials, and equipment.
- F. Provide piping, ductwork, and equipment to allow maximum headroom unless specific mounting heights are indicated. Provide equipment level and plumb, parallel, and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- G. Provide equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- H. Coordinate location of piping, ductwork, sleeves, inserts, hangers, and equipment. Locate to clear other construction, services, and utilities.
- I. Provide piping and ductwork in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- J. Provide systems above accessible ceilings to allow sufficient space for ceiling panel removal.
- K. Verify final equipment locations for roughing-in.
- L. Do not enclose, cover, or put into operation until inspected and approved by authorities having jurisdiction.
- M. The contract documents indicate required valves, fittings, and accessories. If additional materials are required by code or manufacturer's instructions, they shall be provided at no cost to the owner.
- N. Any hot work operations that are performed during this project shall be permitted by use of the FM Global Hot Work Permit System. The FM Global Hot Work Permit System shall be used to supervise all hot work operations (cutting, welding, brazing, grinding, soldering, etc.,) performed outside of any designated welding areas. A written policy statement shall specify who has the authority to issue permits on all shifts. In addition, a constant fire watch shall be continued for 1 hr. after work is completed and the area shall be monitored for an additional 3 hrs. after that.

3.3 PIPING INSTALLATIONS

- A. Provide 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.
 - 1. Provide piping to permit valve servicing.
 - 2. Provide equipment and other components to allow right of way for piping installed at required slope.
 - 3. Provide free of sags and bends.
 - 4. Provide unions or flanges at connections to equipment.
 - 5. Provide fittings for changes in direction and branch connections.
 - 6. Make allowances for application of insulation.
- B. Provide piping adjacent to equipment and machines to allow service and maintenance.
- C. Use transition fitting to join dissimilar piping materials. Connect piping in sizes indicated, but not smaller than sizes of unit connections.
- D. Select system components with pressure rating equal to or greater than system operating pressure.
- E. Plastic piping: Piping shall be installed to avoid damage from adjacent light fixtures. In certain construction situations, these plastic pipes may be installed near recessed light fixtures in ceilings. Light fixtures may have exterior temperatures as high as 194°F.
- F. Plumbing: General layout shown, provide piping and components as required by the local plumbing code. A licensed master plumber shall perform or supervise the work and provide layouts, piping, and fittings as required by code.

3.4 PIPING JOINT CONSTRUCTION

- A. Pipe and tube required by the applicable standard to be cleaned and capped shall be delivered to the job site with factory-applied endcaps. Maintain end-caps through shipping, storage, and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture. Protect stored pipe and tube from moisture and dirt. Elevate above grade. When stored inside, do not exceed the structural capacity of the floor. Protect fittings, flanges, and piping specialties from moisture and dirt. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- B. Joints shall be fabricated, joined, and tested per the piping and fitting manufacturer's instructions. Joint preparation, setting and alignment, joining process, timing, hanger spacing, and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.
- C. Join pipe and fittings according to the following requirements and the relevant specification section specifying piping systems.

- D. Ream ends of pipes and tubes and remove burrs. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- E. Installer Qualifications
 - 1. Pipe fitters shall be qualified in the procedure used to perform the pipe joining.
 - 2. The contractor is responsible for documenting the qualification and training records of each pipe fitter. Pipe fitters shall have current, formal training on the pipe jointing method.
 - 3. Contractor must submit documentation that lists personnel assigned to this project prior to beginning construction who have successfully completed formal training conducted by an authorized manufacturer's representative. The Contractor Training documentation shall be specific to the manufacturer of the pipe and fittings.
 - 4. Personnel's training documentation must be current and have been updated within the past two (2) years. Training received more than two years prior to operation with no evidence of activity within the past 6 months shall not be considered current.
 - 5. Piping Warranty: Contractor shall provide, and document required training and required by the piping system manufacturer in order to maintain the piping manufacturer's warranty.
- F. Provide dielectric isolation at the connection of the dissimilar piping (copper and steel).
- G. 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.
- H. 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.
- I. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
 - 5. 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.
- J. Press connections:
 - 1. The joints shall be pressed using the tools approved by the manufacturer.
 - 2. Always examine the pipe to ensure it is fully inserted into the fitting prior to pressing the joint.
 - 3. Pipe ends shall be cut on a right angle (square) to the pipe.
 - 4. Copper: The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the

tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tools approved by the manufacturer.

5. Steel: Pipe ends shall be reamed chamfered, and paint, lacquer, grease, oil, or dirt shall be removed from the pipe end with an abrasive cloth, or with the Rigid MegaPress pipe end prep tool. Sealing elements shall be verified for the intended use. Visually examine the fitting sealing element to ensure there is no damage. Utilizing a Viega insertion depth inspection gauge mark the tube wall, with a felt tip pen, at the appropriate location, or insert the pipe fully into the fitting and mark the pipe wall at the face of the fitting.

K. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix. PVC Piping: Join according to ASTM D 2855.

3.5 PIPE PENETRATIONS, SLEEVES, & ESCUTCHEONS

A. Pipe penetrations shall be sealed, provide sealants for pipe penetrations

B. Provide allowance for thermal expansion and contraction of copper tubing passing through a wall, floor, ceiling, or partition by wrapping with an approved tape or pipe insulation or by installing through an appropriately sized sleeve.

C. Sleeve Clearance: Sleeve through floors, walls, partitions, and beams shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation.

D. Provide sleeves for pipes passing through concrete and masonry construction. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint. Cut sleeves to length for mounting flush with both surfaces. Provide sleeves in new walls and slabs as new walls and slabs are constructed. Provide steel pipe sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Piping through concrete or masonry shall not be subject to any load from the building construction.

1. Sleeves are not required in drywall construction.
2. Sleeves are not required for core-drilled holes. Provide core drilling as required.

E. To prevent accidental liquid spills from passing to a lower level, provide the following:

1. For sleeves: Extend sleeve 1-1/2 inch above finished floor and provide sealant for watertight joint.
2. For blocked out floor openings: Provide 1-1/2 inch angle set in silicone adhesive around opening.
3. For drilled penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.

- F. 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 Division 7.
- G. Exterior- Pipe Penetrations: Provide sleeve-seal systems in sleeves at service piping entries into building. 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 provide in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.
- H. Escutcheons:
 - 1. Provide escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork.
 - 2. Provide escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 3. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.
- I. Plastic and copper piping penetrating framing members, and within one-inch of the framing, shall be protected with 10-gauge steel nailing plates. The steel plate shall extend along the framing member a minimum of 1.5" beyond the OD of the pipe or tubing.

3.6 PIPE HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Provide 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. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or provide intermediate supports for smaller diameter pipes as specified for individual pipe hangers. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Provide per manufacturer's recommendations and calculations.
- D. Thermal-Hanger Shield Installation: Provide in pipe hanger or shield for insulated piping.
- E. Fastener System Installation: Provide 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. Provide fasteners according to powder-actuated tool manufacturer's operating manual. Provide mechanical-expansion anchors in concrete after concrete is placed and completely cured. Provide fasteners according to manufacturer's written instructions.

- F. Provide hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Provide hangers and supports to allow controlled thermal or 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.
- I. Provide lateral bracing with pipe hangers and supports to prevent swaying.
- J. Provide building attachments within concrete slabs or attach to structural steel. Provide additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Provide concrete inserts before concrete is placed; fasten inserts to forms and provide reinforcing bars through openings at top of inserts.
- K. Provide for expansion and contraction of the piping system. Since changes in direction in the system are usually sufficient to allow for expansion and contraction, hangers must be placed so as not to restrict this movement
- L. Pipe Slopes: Provide hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by plumbing code and ASME B31.9 for building services piping. Piping shall be supported in such a manner as to maintain its alignment and prevent sagging.
- M. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.
- N. Insulated Piping: Attach clamps and spacers to piping.
 - 1. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - 2. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
- O. Equipment Supports: Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor. Grouting: Place grout under supports for equipment and make bearing surface smooth. Provide lateral bracing, to prevent swaying, for equipment supports.
- P. Metal Fabrications: Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations. 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. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

Q. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

R. Hanger and Support Schedule

1. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
2. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
3. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

S. Hanger Spacing

1. Support piping and tubing not listed below according to MSS SP-69 and manufacturer's written instructions.
2. Load Distribution: Provide hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment. Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading.
3. Space and provide hangers with the fewest practical rigid anchor points.
4. Piping shall be supported at intervals sufficiently close to maintain correct pipe alignment and to prevent sagging or grade reversal.
5. Pipe shall be supported at branch ends and at changes of direction.
6. Provide hangers for steel piping with the following maximum horizontal spacing and minimum rod sizes:
 - a. NPS 3/4 to 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
 - b. NPS 1-1/4: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - c. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - d. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - e. NPS 2-1/2 to 3: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - f. NPS 4 to 5: Maximum span, 10 feet; minimum rod size, 5/8 inch.
 - g. NPS 6 to 8: Maximum span, 10 feet; minimum rod size, 3/4 inch.
 - h. NPS 10 to 12: Maximum span, 10 feet; minimum rod size, 7/8 inch.
7. Provide hangers for copper piping with the following maximum horizontal spacing and minimum rod sizes:
 - a. NPS 1/2 and 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - b. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - c. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - d. NPS 1-1/2 to 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - e. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - f. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - g. NPS 4: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - h. Maximum vertical steel and copper pipe attachment spacing: 10 feet.

8. Provide hangers for cast-iron piping with the following maximum horizontal spacing and minimum rod diameters:
 - a. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - b. NPS 3: 60 inches with 1/2-inch rod.
 - c. NPS 4 to 5: 60 inches with 5/8-inch rod.
 - d. NPS 6 to 8: 60 inches with 3/4-inch rod.
 - e. NPS 10 to 12: 60 inches with 7/8-inch rod.
 - f. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
9. Piping Hangers for Plastic Piping:
 - a. Hangers shall not compress, distort, cut, or abrade the piping.
 - b. Hangers shall be placed next to the pipe joint not more than 18" from the point joint.
 - c. Maximum horizontal spacing and minimum rod diameters (pipe temperature 100°F or lower).
 - d. Solvent cemented PVC
 - 1) NPS 2 and smaller: 48" with 3/8-inch rod.
 - 2) NPS 2-1/2: 48" with 1/2-inch rod.
 - 3) NPS 3: 48" with 1/2-inch rod.
 - 4) NPS 4: 48" with 5/8-inch rod.
 - 5) NPS 6: 48" with 3/4-inch rod.
 - 6) NPS 8: 48" with 7/8-inch rod.
 - 7) NPS 10: 48" with 7/8-inch rod.
 - 8) NPS 12: 48" with 7/8-inch rod.
10. Provide supports for vertical piping every 10 feet.

3.7 VALVE INSTALLATION

- A. Valves shall be installed in accordance with the manufacturer's recommendations.
- B. Provide valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown. Locate valves for easy access and provide separate support where necessary.
- C. Provide valves in horizontal piping with stem at or above center of pipe.
- D. Provide valves in position to allow full stem movement.
- E. Provide strainers on supply side of each control valve and elsewhere as indicated or recommended by component manufacturer to have strainer protection. Provide valved drain and hose connection on strainer blow down connection.

1. Provide with provisions for service clearance.
2. Remove and clean strainer after 24 hours of operation and after 30 days of operation.

F. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.

G. Isolation valves shall be installed so that the control valve body may be serviced without draining the supply/return side piping system. Unions shall be installed at connections to screw-type control valves.

H. Provide check valves at each pump discharge and elsewhere as required to control flow direction.

I. Provide hose end drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

3.8 IDENTIFICATION

A. Provide equipment markers on each item of scheduled equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated. Locate markers where accessible and visible. Equipment located above the ceiling that requires servicing shall be labeled on the ceiling using a labeling machine.

1. Letters shall be $\frac{1}{4}$ " high, black.
2. Label equipment above ceiling that requires servicing or access. Locate labels on the ceiling grid, adjacent to the ceiling tile that provides the best access to the valve or item that requires servicing.

B. Piping Identification:

1. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; mechanical rooms; accessible maintenance spaces such as shafts and plenums; and exterior exposed locations as follows:
 - a. Near each valve and control device.
 - b. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - c. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
 - d. At access doors and similar access points that permit view of concealed piping.
 - e. Near major equipment items and other points of origination and termination.
 - f. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - g. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

2. Directional Flow Arrows: Arrows shall be provided to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
3. Apply "Electric Traced" labels to the outside of heat-traced insulation.

C. Provide tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; plumbing fixture supply stops; shutoff valves; faucets; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule. Mount valve schedule on wall in accessible location in each major equipment room. Provide (2) copies of valve schedules in digital format.

D. Relocate mechanical identification materials and devices that have become visually blocked by other work. Clean faces of mechanical identification devices.

3.9 THERMOMETERS AND PRESSURE GAUGES

- A. Provide thermometers and adjust vertical and tilted positions. Provide thermowells with extension on insulated piping. Provide separable sockets in vertical position in piping tees.
- B. Provide pressure gauges in piping tees with pressure-gauge valve located on pipe at most readable position. Provide valve and snubber in piping for each pressure gage for fluids.
- C. Calibrate according to manufacturer's written instructions, after installation.
- D. Adjust faces to proper angle for best visibility. Clean windows and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

3.10 ERECTION OF SUPPORTS AND ANCHORAGES

- A. Fasten wall-hanging items securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated. Fasten recessed-type items to reinforcement built into walls.
- B. Wood: Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor materials and equipment. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Provide fasteners without splitting wood members. Attach to substrates as required to support applied loads.
- C. Metal: Provide in accordance with Division 5. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor materials and equipment. Field Welding: Comply with AWS D1.1.
- D. Grouting: Provide per manufacturer's instructions. Mix and provide grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean surfaces that will come into contact with grout. Provide forms as required for placement of grout. Avoid air

entrapment during placement of grout. Place grout, completely filling equipment bases. Place grout on concrete bases and provide smooth bearing surface for equipment. Place grout around anchors. Cure placed grout.

3.11 FIRESTOPPING

- A. Provide through-penetration firestop systems to comply with firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. UL-Classified Systems shall be provided for rated walls and floors.
- C. Engage an experienced installer who is certified, licensed or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to provide firestop products per specified requirements.
- D. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are provided according to specified requirements.
- E. 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.
- F. Provide components for each through-penetration firestop system that are needed to provide fill materials. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- G. General: Use only through-penetration firestop system products that have been tested for specific fire-resistance-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance. Keep areas of work accessible until inspection by authorities having jurisdiction.
- H. Inspecting Agency: Owner may engage a qualified, independent inspecting agency to inspect through-penetration firestops. Independent inspecting agency shall comply with ASTM E 2174 requirements including those related to qualifications, conducting inspections, and preparing test reports. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements. Proceed with enclosing through-penetration firestop systems with other construction only after inspection reports are issued and firestop installations comply with requirements.
- I. 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 Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and provide new materials to produce systems complying with specified requirements.

3.12 PAINTING

- A. Painting of plumbing and mechanical systems, equipment, and components is specified in Division 9.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.13 PROJECT CLOSEOUT

- A. Starting and Adjusting
 1. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace them with new units, and retest.
 2. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
 3. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 4. Provide commissioning per manufacturer's instructions. This start-up shall include verification of proper installation, system initiation, adjustment, and fine tuning.
 5. Start-up shall not be considered complete until the sequence of operation, including alarms, has been sufficiently demonstrated to the Owner or Owner's designated representative. This jobsite visit shall occur only after hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.
- B. Follow Closeout procedures as per Division 1.
- C. Provide Demonstration and Training in accordance Division 1.
- D. Provide Project Record Documents in accordance with Division 1. In addition, per ASHRAE 90.1-2016: Provide record drawings of the actual installation to the building owner. Record drawings shall include, as a minimum, the location and performance data on each piece of equipment; general configuration of the duct and pipe distribution system, including sizes; and the terminal air or water design flow rates.
- E. Provide Operation and Maintenance information in accordance with Division 1. In addition, per ASHRAE 90.1: Provide an operating manual and a maintenance manual to the building owner. Manuals shall include, at a minimum, the following:
 1. Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance.
 2. Operation manuals and maintenance manuals for each piece of equipment and system requiring maintenance, except equipment not furnished as part of the project. Required routine maintenance actions shall be clearly identified.
 3. Names and addresses of at least one service agency.

4. HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined set points shall be permanently recorded on control drawings at control devices or, for digital control systems, in programming comments.

END OF SECTION 230500

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 1. Division Section: "Common Work Results"

1.2 SUMMARY

- A. Testing, Adjusting, and Balancing shall be completed for the existing air and hydronic systems throughout the existing facility. Refer to the contract drawings for airflow and water flow requirements associated with each functional space.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Reports:
 1. Deficiency Report: Following examination of installed system, prior to balancing, submit report indicating system deficiencies that would prevent proper testing, adjusting, and balancing of systems and equipment to meet specified performance.
 2. TAB Report: Submit the complete testing, adjusting, and balancing report, including any drawings indicating air outlets, thermostats, and equipment identified to correspond with data sheets.
 3. Reports shall be on TABB/SMACNA, AABC, or NEBB forms that indicate information addressing each of the testing methods, readings, and adjustments.
- C. Closeout Submittals: Provide complete copy of TAB report. Include report in Operation and Maintenance Manual.

1.4 QUALITY ASSURANCE

- A. Special Warranty
 - 1. Provide warranty for period of 90 days following submission of completed report, during which time Owner may request a recheck of up to 10% of total number of terminals, or resetting of any outlet, coil, or device listed in the test report.
 - 2. Warranty shall meet the requirements of the following programs:
 - a. TABB – Quality Assurance Program
 - b. AABC – National Project Performance Guarantee
 - c. NEBB – Conformance Certification
- B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- D. TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

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. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed, complete, and operable.
 - 3. Verify HVAC control system is operating within the design limitations.
 - 4. Confirm that the sequences of operation comply with Contract Documents.
 - 5. Automatic and manual dampers are operable and fully open.
 - 6. Verify that controllers are calibrated and function as intended.
 - 7. Verify that controller set points are as indicated.
 - 8. Verify the operation of lockout or interlock systems.
 - 9. Verify the operation of valve and damper actuators.
 - 10. Verify that controlled devices are properly installed and connected to correct controller.
 - 11. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 - 12. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

13. Suitable access to balancing devices and equipment is provided.
14. Thermal overload protection is in place for equipment.
15. Start-up air filters are removed.
16. Final filters are clean and properly installed.
17. Duct and fan systems are clean.
18. Fans are rotating correctly.
19. Life safety and volume dampers are in place and open.
20. Air coil fins are cleaned and combed.
21. Access doors are closed, and duct end caps are in place.
22. Air outlets are installed and connected.
23. Hydronic systems are pressure tested, flushed, filled, and properly vented.
24. Leak testing on duct system has been performed.
25. Pumps are rotating correctly.
26. Start-up/construction strainers have been removed and all permanent strainers are clean and in place.
27. Gauges and/or test ports are properly located for balancing.
28. Service and balance valves are fully open.

B. If deficiencies are evident, submit Deficiency Report to Architect. Do not begin testing, adjusting, and balancing of environmental systems until deficiencies have been remedied.

3.2 AIR SYSTEMS PROCEDURES

A. Adhere to the follow procedure:

1. TABB – SMACNA TAB Procedural Guide, with particular focus on the following chapters: Preliminary TAB Procedures, General Air System TAB Procedures, & TABB Procedures for Specific Air Systems.
2. AABC – National Standards for Total System Balance.
3. NEBB – Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

B. Minimum air procedures shall include the following:

1. Provide TAB for all air systems and components.
2. Test and adjust fan RPM to design requirements.
3. Test and record motor full load nameplate rating and actual ampere draw.
4. Test and record system static pressures, fan suction, and discharge.
5. Adjust all main supply and return air duct to within tolerances of proper design CFM.
6. Test and adjust each diffuser, grille, and register. Reading and tests of diffusers, grilles, and registers shall include design velocity (FPM) and adjusted velocity, design CFM, and adjusted CFM.
7. Test and record outside air, mixed air, and discharge temperatures (D.B. for heating cycle, D.B. and W.B. for cooling cycle).
8. In coordination with the BAS contractor, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.

9. Test and adjust air handling and distribution systems to provide required supply, return, outside, and exhaust air quantities within design tolerance.
10. Make air velocity measurements in ducts by Pitot tube traverse across entire cross-sectional area of duct in accordance with SMACNA equal area method or Log Linear method.
11. Measure air quantities at all air inlets and outlets.
12. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels.
13. Vary total system air quantities by adjustment of fan speeds. Provide drive changes recommendations. Vary branch air quantities by damper regulation.
14. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for loading of filters and coils.
15. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions within specified tolerances.
16. Where modulating dampers or economizers are provided, take measurement at full return air, minimum outside air, and 100% outside air mode of operation.
17. For airflow monitoring devices to perform as intended, field calibration is required. Provide measurement of airflow to assist with calibration.

C. Set system's airflow rates within the following tolerances:

1. Air Handling Systems: Adjust to within plus 10 percent of outlet total plus allowable leakage rate.
2. Air Outlets and Inlets: Adjust total to within plus or minus 10 percent of design for the space.
3. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.3 HYDRONIC SYSTEM PROCEDURES

A. Adhere to the follow procedure:

1. TABB – SMACNA TAB Procedural Guide, with particular focus on the following chapter: Hydronic System TAB Procedures.
2. AABC – National Standards for Total System Balance.
3. NEBB – Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

B. Hydronic balancing shall include the following minimum data:

1. Provide TAB for all hydronic **[and domestic water]** systems and components.
2. Prepare itemized equipment schedules listing all heating and/or cooling elements and equipment in the systems to be balanced. List in order on equipment schedules, by pump or zone according to the design, all heating and/or cooling elements, all zone balancing valves, and circuit pumps, ending with the last items of equipment or transfer element in the respective zone or circuit. Include on schedule sheet column titles listing the location,

type of element or apparatus, design conditions, and measured conditions. Prepare individual pump report sheets for each zone or circuit.

3. Adjust hydronic systems to provide plus or minus 10 percent of required design quantities.
4. Use calibrated Venturi tubes, orifices, metered fittings, pressure gages, and direct-reading instrumentation to determine flow rates for system balance. Where flow-metering devices are not installed, flow balance on temperature difference across various heat transfer elements in the system is acceptable.
5. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
6. Effect system balance with automatic control valves fully open to heat or cooling transfer elements.
7. Adjust hydronic distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
8. Test pumps and adjust flow. Record the following on pump report sheets:
 - a. Suction and discharge pressure.
 - b. Running amps and brake horsepower of pump motor under full flow and no flow conditions.
 - c. Pressure-drop across pump in feet of water and total GPM pump is handling under full flow conditions.
9. Where available pump capacity is less than total flow requirements or individual system parts, proportional balancing must be performed.

C. Set system's water flow rates within the following tolerances:

1. Hydronic Systems: Adjust to within 10 percent of design flow.
2. Hydronic terminal devices: Adjust to within plus or minus 10 percent of design flow.

3.4 ADJUSTING

- A. Recorded data shall represent actual measured or observed conditions.
- B. Permanently mark the setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- C. Final report to include identification of all key outlets, key branches, and key trunks in each air system that shows a critical path of no dampening from the fan to terminal device.
- D. Final report to include identification of all key terminal devices, key branches, and key trunks in each hydronic system that shows a critical path of no throttling of valves from the pump to terminal device.
- E. Leave systems in proper working order by replacing guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.5 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS & ADJUSTMENTS

- A. Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed, and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
- B. Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions. Measure space pressure differential where pressure is used as the design criteria and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
 - 1. For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
 - 2. For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
 - 3. Test room pressurization first, then zones, and finish with building pressurization.
- C. To achieve indicated pressurization, set the supply airflow to the indicated conditions, and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.
- D. In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.
- E. Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

END OF SECTION 230593

SECTION – 230700 – MECHANICAL INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 7 for firestopping materials and requirements for penetrations through fire and smoke barriers.
 - 2. Division 23 Section "Common Work Results for Mechanical"

1.2 SUMMARY

- A. This Section includes insulation and related components for Division 22 & Division 23.

1.3 ACTION SUBMITTALS

- A. Product Data: Identify thermal conductivity, Greenguard Certification, thickness, and jackets (both factory and field applied, if any), for each type of product indicated. For adhesives and sealants, provide documentation including printed a statement of VOC content.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
- C. Indoors: Materials shall have a flame spread index of less than 25 and a smoke developed index of less than 50 when tested in accordance with ASTM E 84, latest revision.
- D. Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

E. Provide accessory materials as part of insulation work under his section shall include closure materials, adhesives, mastics, and support materials; shall be as recommended by insulation material manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
- B. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.
- C. Store tapes, adhesives, mastics, cements, and insulation materials in ambient conditions in accordance with the recommendations of the manufacturer.
- D. Follow manufacturer's recommended handling practices.
- E. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades.
- F. Fiber Glass and Mold: Contractor shall take precaution to protect insulation. Any fiber glass insulation that becomes wet or torn should be replaced at no additional cost. Air handling insulation used in the air stream must be discarded if exposed to water.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields. Coordinate clearance requirements with other trades for insulation application.
- B. Schedule insulation application after testing systems. Insulation application may begin on segments of systems that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Certainteed
 2. Knauf

3. Owens-Corning
4. John Mansville
5. Armstrong
6. Aeroflex USA
7. Nomaco K-Flex
8. Pabco.

2.2 PIPING INSULATION MATERIALS

A. Glass Fiber:

1. Knauf 1000° Pipe Insulation with ECOSE Technology meeting ASTM C547 Type IV Grade A, ASTM C585, and ASTM C795; rigid, molded, noncombustible per ASTM E136; k value: ASTM C335, 0.23 at 75°F mean temperature. Maximum Service Temperature: 1000°F, or Johns Manville's Micro-Lok® HP meeting ASTM C547, Type I, maximum service temperature of 850°F meeting the other requirements. Vapor Retarder Jacket: ASJ/SSL conforming to ASTM C1136 Type I, secured with self-sealing longitudinal laps and butt strips.
2. PVC Fitting Covers: The Proto Fitting Cover System or Johns Manville Zeston® polyvinyl chloride (PVC) parts shall consist of one piece and two piece pre-molded high impact UV-resistant PVC fitting covers with fiberglass inserts and accessories, which include elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings. Fittings shall be made of Zeston® or LoSMOKE® grade PVC, 25/50 rated per ASTM E-84. Thermal Value of fiberglass insert: K value of 0.26 at 75°F; resistance to fungi and bacteria. (ASTM G 21, ASTM G 22): does not promote growth of fungi or bacteria.

B. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. 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. 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."
3. Materials shall have a maximum thermal conductivity of 0.27 Btu-in/h-ft² °F at a 75°F mean temperature when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.
4. Materials shall have a maximum water vapor transmission of 0.08 perm-inches when tested in accordance with ASTM E 96, Procedure-A, latest revision.
5. Provide Armaflex WB finish for outdoor exposed piping.

C. Closed Cell Pipe Insulation: Pittsburgh Corning Foamglas, or approved equal; a lightweight, rigid insulating material composed of millions of completely sealed glass cells, each an insulating space. ASTM C 552-00 "Specification for Cellular Glass Thermal Insulation" operating temperatures from -450°F to +900°F; water permeability 0.00 perm-inch.

D. Field-Applied Jackets For Piping: ASTM C 921, Type 1, unless otherwise indicated.

1. PVC: Johns Manville's Zeston® PVC fittings, jacketing, and accessories or Proto Corporation 25/50 or Indoor/Outdoor, UV-resistant fittings, jacketing and accessories, white. The fitting cover system consists of pre-molded, high-impact PVC materials with fiber glass inserts. Fiber glass insert has a thermal conductivity (k value) of 0.26 at 75° F mean temperature. Closures: stainless steel tacks, matching PVC tape, or PVC adhesive per manufacturer's recommendations.
2. Metal jackets: provide with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
3. Aluminum Jacket: Factory cut and rolled to required size. Comply with ASTM B 209, 3003 alloy, and H-14 temper. Finish and Thickness: Corrugated finish, 0.010 inch thick. Moisture Barrier: 1-mil- thick, heat-bonded polyethylene and Kraft paper. Elbows: Preformed, 45- and 90-degree, short- and long-radius elbows; same material, finish, and thickness as jacket.

2.3 DUCTWORK INSULATION MATERIALS

- A. Flexible Fiber Glass Blanket: Glass Mineral Wool Blanket Insulation: Glass Mineral Wool bonded with a bio-based thermosetting resin. Comply with ASTM C 553, Types I, II, and III, ASTM C 1136 Type II, and ASTM C 1290, Type III. UL/ULC Classified per UL 723 for FSK, FHC 25/50 per ASTM E 84 for PSK only.
 1. Factory-applied jacket: ASJ: White, Kraft paper, fiberglass reinforced scrim with aluminum foil backing; complying with ASTM C 1136, Type I.
 2. Basis-of-Design Product: Subject to compliance with requirements, provide Knauf Insulation; Atmosphere Duct Wrap.
 3. Density: 1.5 PCF
 4. R-Value: R6.0 minimum for 1-1/2" thick blanket (k=0.25).
- B. Rigid Fiber Glass Board: Johns Manville's 817 Series Spin-Glass® or Knauf Insulation Board with ECOSE Technology meeting ASTM C 612 Type IA and IB; rigid. Maximum Service Temperature: 450°. Density: Minimum 3.0 PCF; R4.2 per inch. Vapor Retarder Jacket: ASJ conforming to ASTM C1136 Type I, or FSK or PSK conforming to ASTM C1136 Type II in combination with protective jacket where necessary. R-Value: R6.0 minimum for 1-1/2" thick blanket (k=0.25).

PART 3 - EXECUTION

3.1 GENERAL APPLICATION REQUIREMENTS

- A. Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature. Insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification. Store tapes,

adhesives, mastics, cements, and insulation materials in ambient conditions in accordance with the recommendations of the manufacturer. Follow manufacturer's recommended handling practices. The contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The contractor shall also use all means necessary to protect work and materials installed by other trades. Contractor shall take precaution to protect insulation. Any fiber glass insulation that becomes wet or torn should be replaced at no additional cost. Air handling insulation used in the air stream must be discarded if exposed to water.

- B. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application. Verify that systems to be insulated have been tested and are free of defects. Verify that surfaces to be insulated are clean and dry. Proceed with installation only after unsatisfactory conditions have been corrected. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin. Ensure that pipe and fitting surfaces over which insulation is to be installed are clean and dry. Ensure that insulation is clean, dry, and in good mechanical condition with factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation. Ensure that pressure testing of piping and fittings has been completed prior to installing insulation.
- C. Installer Qualifications: Skilled mechanics shall have successfully completed an apprenticeship program or another craft training program.
- D. Provide insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout, including the length of ducts and fittings, valves, and specialties. Provide per "National Commercial & Industrial Insulation Standards" – MICA Manual.
- E. Provide insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each system as specified in insulation system schedules.
- F. Provide accessories compatible with insulation materials and suitable for the service.
- G. Provide insulation with longitudinal seams at top and bottom of horizontal pipe runs and equipment. Provide multiple layers of insulation with longitudinal and end seams staggered.
- H. There shall be no glass fibers exposed to the air. Bond seams and joints with adhesive recommended by the insulation material manufacturer.
- I. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- J. Jackets And Finishes: Draw jacket tight and smooth. 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. 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 2 inches o.c. For below ambient services, apply vapor-

barrier mastic over staples. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

- K. Keep insulation materials dry during application and finishing.
- L. Provide insulation over fittings, valves, and specialties, with continuous thermal and the least number of joints practical.
- M. Provide removable insulation covers at fittings and equipment that require servicing and locations with service requirements.
- N. Locate seams in the least visible location.
- O. For above-ambient services, do not install insulation to the following: testing agency labels and stamps, nameplates, and cleanouts.
- P. Insulation thicknesses and installations shall meet or exceed the requirements of the local energy code, or thicknesses indicated, whichever is of superior insulating performance. If piping type is omitted from list below, provide insulation per energy code or as per similar duty.
- Q. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- R. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- S. Insulate instrument connections for specialties (examples: thermometers, sensors, etc.) 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.
- T. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- U. 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.
- V. Penetrations
 - 1. Division 7 for firestopping materials and requirements for penetrations through fire and smoke barriers.
 - 2. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Provide insulation continuously through walls and partitions.
 - 3. Insulation Installation at Roof or Aboveground Exterior Wall Penetrations: Provide insulation continuously through penetrations.

- a. Seal penetrations with flashing sealant.
- b. For applications requiring only indoor insulation, terminate insulation above roof/wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, provide insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
- c. Extend jacket of outdoor insulation outside roof/wall flashing at least 2 inches below top of roof flashing.
- d. Seal jacket to roof/wall flashing with flashing sealant.

4. Insulation Installation at Fire-Rated Penetrations:
 - a. Fire Dampers: 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.
 - b. Pipe or duct penetrations (no fire damper): Provide insulation continuously through penetrations of fire-rated walls and partitions. Comply with requirements in Division 7 for firestopping and fire-resistive joint sealers.

3.2 INSTALLATION OF PIPING INSULATION

- A. Metal shields shall be provided between hangers or supports and the piping insulation.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 1. Provide No-Sweat valve wraps at all valves and fittings.
 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 and 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 close to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate 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.
 5. For below-ambient services, provide a design that maintains vapor barrier.
 6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Provide vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 7. 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.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric, provide 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.

C. Flexible Elastomeric Insulation

1. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
2. Insulation Installation on Pipe Flanges: Provide pipe insulation to outer diameter of pipe flange. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation. 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. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
3. Insulation Installation on Pipe Fittings and Elbows: Provide mitered sections of pipe insulation. 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.
4. Insulation Installation on Valves and Pipe Specialties: Provide preformed valve covers manufactured of the same material as pipe insulation when available. When preformed valve covers are not available, provide 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. Provide insulation to flanges as specified for flange insulation application. 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.
5. After the adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Prior to applying the finish, the insulation shall be wiped clean with denatured alcohol. The finish shall not be tinted. To insure good adhesion, the temperature should be above 50°F during application and drying.
6. Outdoor exposed piping shall be painted with two coats of Armaflex WB Finish. Prior to applying the Finish, the insulation shall be wiped clean with denatured alcohol. The Finish shall not be tinted. Outdoor exposed piping shall have seams located on the lower half of the pipe.

3.3 PIPE APPLICATION SCHEDULE

- A. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements. For piping systems not indicated, insulate to with a similar thickness and type as those specified. Insulation thicknesses and installations shall meet or exceed the requirements of the local energy code, or thicknesses indicated, whichever is of superior insulating performance.
- B. PVC jackets shall be provided with 1-inch overlap at longitudinal seams and end joints, for horizontal applications. Seal with manufacturers recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge. Provide PVC jackets in the following locations:

1. For piping exposed in mechanical rooms within 6 feet above finished floor or high traffic areas.
2. Exposed vertical piping in finished spaces.

C. Domestic hot water:

1. Runouts and non-recirculated portions: Glass Fiber 1/2" thickness.
2. Recirculating piping including the supply and return: 1-1/4" and less: Glass Fiber, 1" thickness; 1-1/2 and larger: Glass Fiber, 1.5" thickness.

D. Domestic cold water: Glass Fiber, 1/2" thickness.

E. Heating hot water supply and return:

1. Pipe size 1-1/4" and less: Glass Fiber; 1-1/2" thickness.
2. Pipe size 1-1/2" and larger: Glass Fiber; 2" thickness.
3. Insulation is not required for exposed piping through floor for convectors and radiators.
4. Insulation is not required strainers, control valves, unions, and balancing valves associated with piping 1" or less diameter. Insulate piping to within approximately 3/4-inch of un-insulated items.

3.4 INSTALLATION OF DUCTWORK INSULATION

A. Flexible Fiberglass Blanket Insulation Installation:

1. Secure with adhesive and insulation pins. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces. Apply adhesive to entire circumference of ducts and to surfaces of fittings and transitions.
2. Firmly butt joints.
3. Provide either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts.
4. 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.
5. Provide insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Provide insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. 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.

B. Board 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, for 100 percent coverage of duct and plenum surfaces. Apply adhesive to entire circumference of ducts and to surfaces of fittings and transitions.

2. Provide either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts.
3. Provide insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Provide insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
4. 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.

C. For ducts and plenums with surface temperatures below ambient, provide 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. Provide vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal. Provide vapor stops for ductwork and plenums operating below 50°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.

D. Fire-rated insulation system installation: Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating. Insulate duct access panels and doors to achieve the same fire rating as duct.

3.5 DUCTWORK APPLICATION SCHEDULE

A. For duct systems not indicated, insulate to with a similar thickness and type as those specified. Insulation thicknesses and installations shall meet or exceed the requirements of the local energy code, or thicknesses indicated, whichever is of superior insulating performance.

B. Application schedules identify ductwork thickness, and jacket requirements. For duct systems not indicated, insulate to with a similar thickness and type as those specified. Insulation thicknesses and installations shall meet or exceed the requirements of the local energy code, or thicknesses indicated, whichever is of superior insulating performance.

C. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment: Flex connectors, metal ducts with duct liner, factory-insulated flexible ducts, factory-insulated plenums, casings, and access doors.

D. Supply Ducts:

1. Concealed or Unconditioned: Flexible Fiber Glass Blanket; 1.5" thickness, R6 minimum.
2. Exposed to heated or non-air conditioned spaces: Flexible Fiber Glass Blanket; 1.5" thickness R6 minimum.

3. Exposed to Air-Conditioned Space: None
- E. Return ducts within conditioned space: None required.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

1.3 DEFINITIONS

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority -Third Party contracted by the Owner.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

1.5 CONTRACTOR'S RESPONSIBILITIES

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.

- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
 6. Test and inspection reports and certificates.
 7. Corrective action documents.
 8. Verification of testing, adjusting, and balancing reports.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
 2. The testing and balancing Subcontractor shall use the same instruments (by model and serial number) that were used when original data were collected.

3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R Subcontractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R systems, subsystems, and equipment Testing Procedures

- A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in HVAC boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.
- B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls." Assist the CxA with preparation of testing plans.
- C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R Subcontractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- D. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
 - 1. Value of previously stored materials put in place after date of previous Application for Payment and on or before date of current Application for Payment.
 - 2. Value of materials stored since date of previous Application for Payment and remaining stored as of date of current Application for Payment.

END OF SECTION 230800

**SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC (NIC – ISSUED FOR
REFERENCE AND COORDINATION ONLY)**

PART 1 - GENERAL

1.1 SUMMARY

- A. The temperature control system modifications and upgrades associated with this project shall be furnished and installed under separate contract with the Maine Turnpike Authority by XL Mechanical. This section is issued for reference only. With that said, however, it shall be the responsibility of the contractor to coordinate this work with the overall schedule.**
- B. All low voltage cabling associated with the BACS system shall be furnished and installed under the BACS contract. Associated line voltage power wiring as required to facilitate the upgrades to the BACS shall be included in the scope of the renovation contract, coordinate with Division 26 as required. Refer to Part 3 herein for additional requirements.**
- C. The intent of this specification is to provide extensions and alterations to the existing open source Building Automation Control System (BACS) based on the Tridium Niagara N4 Platform and a network of freely programmable interoperable open protocol BACnet digital controllers. The Interoperable BACnet controllers shall be fully programmable via the embedded Niagara WorkBench tool requiring only a web browser to complete the programming process. Upgrades and alterations specified herein apply to both new and existing equipment and systems within the facility. It shall be the responsibility of the BACS contractor to determine which, if any existing sensors, cabling, actuators, etc. may be re-used for operation with the new BACS. BACS contractor shall provide all required hardware, software, and programming for a complete operational system as specified herein.**
- D. Products requiring a licensed, non-embedded, off site programming tool are not acceptable. Open source as referred to herein shall mean that the Tridium Niagara Network Area Controller and the Interoperable Digital BACnet Controllers (IDC) products are available from multiple contractor and vendor sources, affording the owner freedom of choice and competitive bidding for the initial installation of the (BACS) and future system expansions and modifications not limited by contractor, vendor or networking protocol. No territorially restricted OEM brands, single vendor or “branch only” products are acceptable. All products must be available for purchase by any qualified contractor that the owner chooses to do the initial installation and any future expansion or modifications.**
- E. Furnish all labor, materials, equipment, and service necessary for a complete and operating Building Automation Control System (BACS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only.**

- F. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.
- G. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s).

1.2 SYSTEM DESCRIPTION

- A. The project scope shall provide alterations and extensions to the recently installed Tridium Niagara Building Automation Control System which shall include a network of interoperable, stand-alone digital controllers communicating via BACnet™ communication protocols to a Network Area Controller (NAC). Temperature Control System products shall be by approved manufacturers. Equivalent BACnet™ products must be approved in writing by the consulting Engineer and be submitted for approval ten (10) days prior to the date of the bid submittal. Specific scope items shall include but not necessarily be limited to the following:
 - 1. Control for radiant ice melt circuit for the main entry plaza to include source water control valve, load side pump, and all required sensors and programming. It is the intent that a Tekmar 680 snow melting control panel be used to control the system furnished and installed under Division 23-refer to Section 238316, with Bacnet integration to the BACS, for monitoring capabilities.
 - 2. Integration with new Stulz CRAC unit controllers for monitoring, status alarm, and scheduling for the fans, humidifiers, and chilled water control valves. Refer to Section 230993-Sequence of Operation for specific control parameters and points.
 - 3. Existing Chiller control and monitoring.
 - 4. Existing Boiler Integration to the BACS.
 - 5. Pump control and monitoring.
 - 6. Existing Radiant Floor Manifold Control and Monitoring.
 - 7. New and Existing Exhaust Fan Control and Monitoring.
 - 8. New controllers and controls for the three rooftop units, including but not limited to mixing box dampers, humidity control, chilled water/hot water control valves, fan control (supply and return), space pressurization, etc. Refer to Section 230993-Sequence of Operation for specific control parameters and points.
 - 9. Replace and re-map existing VAV controllers such that the VAV's and reheat for each floor are contained on the controller for the rooftop unit serving that floor.
 - 10. Primary and Back-Up Niagara N4.11 Supervisors with 8 TB External Drives.
 - 11. Raid configured Rack Mounted Servers.
- B. The Building Automation Control Systems (BACS) consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and perform functions specified.
- C. The Building Automation Control System shall be comprised of Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the owner's local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers,

via the Internet and/or local area network. Each NAC shall communicate to BACnet™ (IBC) controllers and other open protocol systems/devices provided under Division 23 or Division 26.

- D. The BACS as provided in this Division shall be based on a hierarchical architecture incorporating the Niagara N4 Framework™. Equivalent products must be approved in writing by the consulting Engineer and be submitted for approval ten (10) days prior to the date of the bid submittal. Systems not developed on the Niagara N4 Framework™ platform are unacceptable.
- E. The BACS shall monitor and control equipment as called for by the “Sequence of Operation” and points list.
- F. The BACS shall provide full graphic software capable of complete system operation for up to 34 simultaneous Thin-Client workstations.
- G. The BACS shall provide full graphic operator interface to include the following graphics as a minimum:
 - 1. Home page to include a minimum of six critical points, i.e. Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW etc.
 - 2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
 - 3. Detail graphics for each mechanical system to include; AHUs (Air Handling Units), ERUs (Energy Recovery Units), TUs (Terminal Units), EFs (Exhaust Fans), Chillers and associated controls, Boilers, and Converters as a minimum.
 - 4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.
- H. The BACS shall provide the following data links to electronically formatted information for operator access and use.
 - 1. Project control as-built documentation; to include all BACS drawings and diagrams converted to Adobe Acrobat .pdf filers.
 - 2. TCS Bill of Material for each system, i.e. AHU, RTU, FCU, Boiler etc.
 - 3. Technical literature specification data sheets for all components listed in the BACS Bill of Material.
- I. The BACS shall provide automated alarming software capable of sending messages to email compatible cellular telephones and pagers via the owner's e-mail service. The email alarm paging system shall be able to segregate users, time schedules, and equipment, and be capable of being programmed by the owner.
- J. It is preferable that any dedicated configuration tool required for controller configuration have the capability to be launched from within the applicable Network Management Software. If the configuration tool(s) can not be launched from the Network Management Software, any software required for controller configuration shall be included as a leave-behind tool with enough license capability to support the installation.

K. The contractor shall provide the appropriate quantity of legal copies of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be generally available in the market. No closed and/or unavailable tools will be permitted. Contractor shall convey all software tools and their legal licenses at project close out.

1.3 SUBMITTAL

A. Four copies of shop drawings of the components and devices for the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions for all controllers, valves, dampers, sensors, routers, etc. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package. Division 26 contractors supplying products and systems, as part of their packages shall provide catalog data sheets, wiring diagrams and point lists to the Division 23 contractor for proper coordination of work.

B. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media, and protocol. Though the Division 23 and 26 contractors shall provide these diagrams for their portions of work, the Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Wide Area Network (WAN) and/or Local Area Network (LAN) utilized by the BACS.

1. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system expansion with minimal infrastructure modifications.

C. Submittal shall also include a complete point list of all points to be connected to the BACS. Division 23 and 26 contractors shall provide necessary point lists, protocol documentation, and factory support information for systems provided in their respective divisions but integrated into the BACS.

D. Submittal shall also include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining changes to be based on review comments from the A/E design team and/or Owner.

E. Upon completion of the work, provide a complete set of 'as-built' drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ or Visio™ compatible files. Eight copies of the 'as-built' drawings shall be provided in addition to the documents on compact disk. Division 23 and 26 contractors shall provide as-builts for their portions of work.

The Division 23 contractor shall be responsible for as-builts pertaining to overall BACS architecture and network diagrams. All as-built drawings shall also be installed into the BACS server in a dedicated directory.

1.4 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

DDCS	Direct Digital Control System
	Building Automation Control System
GUI	Graphical User Interface
IBC	Interoperable BACnet Controller
IDC	Interoperable Digital Controller
LAN	Local Area Network
NAC	Network Area Controller
OOT	Object Oriented Technology
PICS	Product Interoperability Compliance Statement
PMI	Power Measurement Interface
POT	Portable Operator's Terminal
TCS	Temperature Control System
WAN	Wide Area Network
WBI	Web Browser Interface

1.5 DIVISION OF WORK

A. The BACS contractor shall be responsible for all controllers (IDC and IBC), control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.

B. The BACS contractor shall be responsible for the Network Area Controller(s) (NAC), software and programming of the NAC, graphical user interface software (GUI), development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, LonWorks network management and connection of the NAC to the local or wide area network.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. Division 26, Electrical:

1. Providing motor starters and disconnect switches (unless otherwise noted).
2. Power wiring and conduit (unless otherwise noted).

3. Provision, installation and wiring of smoke detectors (unless otherwise noted).
4. Other equipment and wiring as specified in Division 26.

1.7 AGENCY AND CODE APPROVALS

- A. All products of the BACS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.
 1. UL-916; Energy Management Systems
 2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "signal Equipment"
 3. CE
 4. FCC, Part 15, Subpart J, Class A Computing Devices

1.8 SOFTWARE LICENSE AGREEMENT

- A. The Owner shall agree to the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.
- B. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, BACS, and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the owner.
- C. The owner, or his appointed agent, shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and /or configured for use within Niagara N4 Framework (Niagara) based controllers and/or servers and any related LAN / WAN / Intranet and all connected routers and devices.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.10 QUALITY ASSURANCE

- A. Proven Experience: Provide a list of no less than ten similar projects which have building control systems specified. These projects must be on-line and functional such that the Owner's Representative would observe a direct digital control system in full operation. The Contractor must be a direct, wholly owned branch of a national control's manufacturer, or a representative not a wholesale distributor.
- B. Quality of Compliance: Control systems shall be installed by trained control mechanics regularly employed in installation and calibration of BACS equipment by the manufacturer of temperature control equipment.
- C. Contractor Requirements
 - 1. Longevity: The BACS contractor shall have a minimum of ten years experience installing, and servicing computerized building systems. All subcontractors utilized by the BACS contractor shall have a minimum of five-year experience within their appropriate trades.
 - 2. Past Projects: The BAS contractor shall have completed a minimum of ten projects within the last five years that are at least equal in dollar value and scope to this project. A list of similar projects, dollar volume, scope, contact name and contact number shall be provided by the BAS contractor if asked for by the owner.
 - 3. Personnel, Coverage and Response Capabilities: The BACS contractor shall have a minimum of ten full time electronic service personnel and two factory trained DDC control technicians within a 140 mile radius of the project location
 - 4. The BACS contractor shall have an established 24-hour emergency service organization. A dedicated telephone number shall be provided to the owner for requesting emergency service. A maximum of four hour, electronic service technician on sight, response time shall be guaranteed by the BACS contractor.
 - 5. The Potential Low Bidder will submit with Bid Documents a qualification statement demonstrating how the above Contractor requirements shall be achieved. Any Potential Low Bidder that does not meet all of the criteria shall not be considered and shall be rejected for not complying with the specifications.

1.11 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

PART 2 - MATERIALS

2.1 GENERAL

- A. The Building Automation Control System (BACS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, graphical user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.
- B. The installed system shall provide secure password access to all features, functions and data contained in the overall BACS.

2.2 ACCEPTABLE MANUFACTURERS

- A. Basis-of-Design (No exceptions): Tridium Niagara-N4™. Subject to compliance with requirements, provide either the product named or an alternate product by one of the other manufacturers specified. System must operate on an open licensed JACE with the N4 Workbench. No Appliance may be used. All JACE controllers shall operate with the Brand ID set to “none”, and compatibility modes set for “all”.
- B. Acceptable Manufacturer(s)
 - 1. Honeywell WEBS
 - 2. Siemens Talon

2.3 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

- A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet™ technology, MODBUS™, OPC, and other open and proprietary communication protocols into one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-2001 and BACnet to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP,) and/or RS-485 (BACnet MSTP) as specified.
- C. All components and controllers supplied under this Division shall be true “peer-to-peer” communicating devices. Components or controllers requiring “polling” by a host to pass data shall not be acceptable.

- D. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. Systems requiring proprietary database and user interface programs shall not be acceptable.
- E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
 - 1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for local network connected user interfaces.
 - 2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.3 CONTROL SYSTEM HARDWARE

- A. Alternate device manufacturers will be considered with the approval of the engineer.
- B. Space Temperature Wall Module: Temperature sensing modules mounted on the wall in occupied spaces. Optional setpoint, indication, and override switches must be provided as specified.
 - 1. Manufacturers: Subject to compliance with requirements. Provide products by one of the manufacturers specified.
 - a. ACI
 - b. Honeywell
 - c. Siemens Building Technologies
 - d. Trend
 - 2. Sensor shall contain digital display and user function keys along with temperature sensor. Sensor shall function as occupant control unit. It shall allow occupant to raise and lower setpoint and activate terminal unit for night override use all within limits as programmed by building operator.
 - 3. Provide means for occupant to view room setpoint, room temperature and outside air temperature at each controller. Override time may be set and viewed in 0.1 hour increments. Override time countdown shall be automatic, but may be reset to zero using function keys on unit. Display shall be blank in unoccupied mode unless a function button is pressed.
 - 4. Space temperature sensors shall be accurate to plus or minus 0.5 deg. F at 77 deg. F.

C. CO2 Sensors.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. ACI
 - b. Honeywell
 - c. Siemens Building Technologies
 - d. TelAire
 - e. Vaisala
2. Carbon Dioxide sensors shall be 0-10 Vdc, 2-10 Vdc, or 4-20 mA linear analog output type, with corrosion free gold-plated non-dispersive infrared sensing, designed for duct or wall mounting.
3. Sensor shall incorporate internal diagnostics for power, sensor, analog output checking, and automatic background calibration algorithm for reduced maintenance. Sensor range shall be 0-2000 PPM with +/- 75 PPM accuracy at full scale.
4. Where specified, sensor shall have an LCD display that displays the sensor reading and status.

D. Control Valves: (*Globe Type*) Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
2. Two-position valves shall be line size.
3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's specified maximum differential pressure shall not be exceeded in order to prevent cavitation.
4. Two-way proportional valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through, and linear through the bypass. Rangeability shall be 50:1 or greater.
5. Provide valve position indicator and a method to operate valves manually during system start-up, or actuator power loss or failure on all valves.
6. Leakage rate shall be no more than ANSI Class III (for heating) or ANSI Class IV (for cooling).
7. Valves 1/2 inch through 3 inches shall be screwed pattern except where solder connections are specified for valves 1/2 or 3/4 inches.
8. Three-way valve bypass ports shall be of Cv to provide constant flow through the control loop.

9. Two-way valves shall close off against the net differential pressure resulting from the maximum head pressure of the system pumps less all loop pressure losses. Three-way valves shall close off against the difference in head pressure between the controlled load and the bypass line.
10. Valves 2-1/2 inch and larger shall be flanged and ANSI/ASME-rated to withstand the pressures and temperatures specified.
11. Valves shall have stainless-steel stems and spring loaded Teflon packing with replaceable discs.

E. Control Valves: (*Characterized Ball Valves*) Control valves 1/2 to 3 inches shall be 2-way or 3-way forged brass screwed pattern constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
 - e. Griswold Controls
2. Two-position valves shall be line size.
3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's specified maximum differential pressure shall not be exceeded in order to prevent cavitation.
4. Two-way proportional valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through and linear flow through the bypass.
5. Leakage rate shall be ANSI Class IV (no more than 0.01% of Cv).
6. Fluid temperature range shall be between -22 and +250 degrees F. water or glycol solutions up to 50%. Piping and valves shall be properly insulated to prevent formation of ice on moving parts.
7. Valves shall be rated for no less than 360 psig at 250 degrees F.
8. Provide a method to operate valves manually during system start-up, or actuator power loss or failure on all valves.
9. Two-way valves shall close off against 70 psi minimum, and three-way valves shall close off against 40 psi minimum.
10. Valves shall have stainless-steel or chemically nickel-plated brass stem and throttling port.
11. Actuator shall be available with NEMA 3R (IP54) rated enclosure suitable for outdoor installation.
12. Valves shall be tagged with Cv rating and model number.

F. Control Valves: (*Characterized Ball Valves*) Control valves 4 to 6 inches shall be 2-way or 3-way cast iron ANSI Class 125 flanged connections as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. Griswold Controls
2. Two-position valves shall be line size.
3. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings). Manufacturer's maximum differential pressure shall not be exceeded in order to prevent cavitation.
4. Two-way water valves shall have equal percentage flow characteristics. Three-way valves shall have equal percentage flow characteristics straight through and linear with 20% reduced flow through the bypass. Rangeability shall be 100:1 or greater.
5. A-port leakage rate shall be ANSI Class IV (no more than 0.01% of Cv) or better.
6. Fluid temperature range shall be between -22 and +250 degrees F. water or glycol solutions up to 50%. Piping and valves shall be properly insulated to prevent formation of ice on moving parts.
7. Valves shall be rated for no less than 240 psig at 250 degrees F.
8. Provide a method to operate valves manually during actuator power loss or failure.
9. Two-way valves shall close off against 70 psi minimum, and three-way valves shall close off against 40 psi minimum.
10. Valve ball and stem shall be 316 stainless-steel.
11. Actuator shall be available with NEMA 3R (IP54) rated enclosure suitable for outdoor installation.
12. Valves shall be tagged with Cv rating and model number.

G. Butterfly Control Valves: Where specified, butterfly control valves 2" to 20" in size shall be cast iron body type for 2-way applications and constructed for tight shutoff and shall operate against system pressures and differentials. Three-way applications shall consist of 2-way valves assembled to a "Tee" fitting with common actuators and operating linkage.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Bray
 - b. Honeywell
 - c. Johnson Controls
 - d. Siemens Building Technologies
 - e. Tyco International
2. Valves shall have tapped lugs for standard flange connection, and meet ANSI/ASME requirements to withstand the pressures and temperatures encountered.
3. Valve shall have a corrosion, ultra-violet, and wear-resistant coating for outdoor applications.
4. Resilient-seated valves shall use food-grade elastomeric seats. Seat shall also function as the flange gaskets.

5. Valves shall be designed for isolation and the absence of downstream piping at rated differential pressure.
6. All valves shall be line size.
7. Proportional control valves shall be sized for a nominal pressure drop of 5.0 psid at rated flow (except as may be noted on the drawings) up to a maximum stroke of 60° disk rotation. Manufacturer's maximum fluid velocity shall not be exceeded in order to prevent cavitation.
8. Valves shall be rated for bubble tight shutoff at no less than 150 psi differential pressure for full cut valves, or 50 psi for under cut valves.
9. Valve disc shall be of corrosion-resistant construction appropriate for the controlled media such as nylon-coated cast iron, aluminum bronze, or stainless steel.
10. Valve stems shall be stainless steel, with inboard top and bottom bearings, and an external corrosion resistant top bearing to absorb actuator side thrust.
11. Actuator mounting flange shall conform to ISO 5211 for actuator interchangeability.
12. Actuator shall be available with NEMA 4X (IP65) rated enclosure suitable for outdoor installation.
13. Valves shall be tagged with Cv rating and model number.

H. Actuators, General. All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with actuators sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off. Valves shall be provided with actuators suitable for floating or analog signal control as required to match the controller output. Actuators shall be power failure return type where valves or dampers are required to fail to a safe position and where specified.

I. Non-Spring Return Low Torque Direct Coupled 35 & 70 lb-in Actuators. Actuators shall be 35 or 70 lb-in. with strokes adjustable for 45, 60, or 90 degree rotation applications and designed for operation between 20 and 125 F.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
2. Each actuator shall also have a minimum position adjustable rotation of 0 to 30 degrees.
3. Actuators shall be for floating or two position (ML 6161 or ML6174) control, or for 4-20 mA or 2-10Vdc (ML7161 or ML7174) input signals.
4. Analog control actuators shall have a cover mounted direct/reverse acting switch.
5. Actuator motor shall be magnetically coupled or shall have limit switch stops to disengage power at the ends of the stroke.
6. Actuators shall be direct connected (no linkages) and provided with a manual declutch for manual positioning.
7. Actuators shall have NEMA 1 environmental protection rating and be 24 volt and UL listed with UL94-5V plenum requirement compliance.

8. Minimum design life of actuators shall be for 1,500,000 repositions and 35 lb-in. models shall be designed for 50,000 open-close cycles and 70 lb-in. models shall be designed for 40,000 open-close cycles.
9. Actuator options shall include 1) Auxiliary feedback potentiometers, 2) open-closed indicator switches, 3) actuator timings of 90 seconds, 3 minutes, or 7 minutes, one or two auxiliary switches, and 4) torque of 35 or 70 lb-in.

J. Non-Spring Return High Torque 177 and 300 lb-in Actuators. Actuators shall be UL listed 24 Vac in NEMA 2 enclosures designed for operation between -5 and 140 F.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
2. Rotation direction shall be switch selectable.
3. Minimum design life of actuators shall be for 1,500,000 repositions and for 60,000 open-close cycles.
4. Actuators shall be suitable for the controller output signals encountered, floating or analog, and shall have full cycle timing of 95 seconds.
5. Actuators shall be direct connected (no linkages) and provided with a manual declutch for manual positioning.

(Select one or more of the following descriptions required)

Actuators shall have 300 lb-in. torque.

Actuators shall have 177 lb-in. torque with adjustable stroke, 30 to 90 degrees.

Actuators shall have 177 lb-in. torque with adjustable stroke, 30 to 90 degrees, and shall auxiliary end switches to annunciate full open and full closed positions.

K. Spring Return Direct Coupled Actuators. Actuators shall have torque ratings of 44lb-in., 88 lb-in., or 175 lb-in. Actuators shall be modulating 90 seconds nominal timing or two-position 45 seconds nominal timing types with strokes for 90 degree rotation applications and designed for operation between -40 and 140 F.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Johnson Controls
 - c. Siemens Building Technologies
 - d. TAC
2. Each torque rating group shall have optionally selected control types, floating control, 2-position 24 Vac, 2-position line voltage, or analog input which is switch selectable as 0-10Vdc, 10-0 Vdc, 2-10 Vdc, or 10-2 Vdc.

3. Actuator spring return direction (open or closed) shall be easily reversed in the field, and actuators shall spring return in no greater than 20 seconds.
4. Actuators shall be direct connected (no linkages), and shall have integral position indication.
5. Actuators shall have NEMA 2 environmental protection rating, and UL approved and plenum rated per UL873.
6. Minimum design life of modulating actuators shall be for 1,500,000 repositions and 60,000 spring returns, except 2-position actuators shall be for 50,000 spring returns.
7. Each actuator shall be provided with a manual power-off positioning lever for manual positioning during power loss or system malfunctions, including a gear-train lock to prevent spring action.
8. Upon power restoration after gear lock, normal operation shall automatically recur.

L. Fast Acting Two Position Fire & Smoke Actuators. Fire/smoke damper actuators shall be direct connected (no linkages) two-position spring return types with stroke for 90 degree nominal rotation applications and designed for 60,000 full stroke cycles and normal operation between 0 and 130 F.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - a. Honeywell
 - b. Siemens Building Technologies
2. Actuators control shall be compatible with SPST control switch and with torque ratings of 30 lb-in.
3. Actuator timing shall be 25 seconds maximum in powered instances and shall spring-return in 15 seconds.
4. Actuators shall be UL listed with UL873 plenum rating with die-cast aluminum housing with integral junction box and conduit knockouts, and designed to operate reliably in smoke control systems requiring UL555S ratings up to 350F.
5. The actuator shall be designed to operate for 30 minutes during a one-time excursion to 350F.
6. Actuator shall require no special cycling during long-term holding, and shall "hold" with no audible noise at a power consumption of approximately half of the driving power.
7. Actuators shall be 24 volt or 120 volt with models for clockwise (add a B suffix) and counter-clockwise (add an A suffix) spring return.

M. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Control panels shall meet all requirements of Title 24, California Administrative Code. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels. A complete set of 'as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All work described in this section shall be performed by system integrators or contractors that have a successful history in the design and installation of integrated control systems. The installing office shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience.
- B. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.
- C. Drawings of the BACS network are diagrammatic only and any apparatus not shown, but required to make the system operative to the complete satisfaction of the Authority shall be furnished and installed without additional cost.
- D. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by this contractor in accordance with these specifications.
- E. Equipment furnished by the HVAC Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by this contractor.

3.2 WIRING

- A. All electrical control wiring and power wiring to the control panels, NAC, computers and network components shall be the responsibility of the BACS contractor.
- B. The electrical contractor (Div. 26) shall furnish all power wiring to electrical starters and motors.
- C. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. All BACS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 26) unless otherwise allowed by the National Electrical Code or applicable local codes. Where BACS plenum rated cable wiring is allowed it shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner.

3.3 WIRING CRITERIA

- A. Run circuits operating at more than 100 volts in rigid or flexible conduit, metallic tubing, covered metal raceways, or armored cable.

- B. Do not run binary control circuit wiring in the same conduit as power wiring over 100 volts. Where analog signal wiring requires conduit, do not run in the same conduit with AC power circuits or control circuits operating at more than 100 volts.
- C. Provide circuit and wiring protection required by NFPA 70.
- D. Run all wiring located inside mechanical rooms in conduit.
- E. Do not bury aluminum-sheathed cable or aluminum conduit in concrete.
- F. Input/output identification: Permanently label each field-installed wire at each end with descriptive text using a commercial wire marking system that fully encircles the wire, cable, or tube. Locate the markers within 2 inches of each termination. Match the names and I/O number to the project's point list. Similarly label all power wiring serving control devices, including the word "power" in the label. Label all terminal blocks with alpha/numeric labels. All wiring and the wiring methods shall be in accordance with UL 508A.
- G. For controller power, provide new 120 VAC circuits, with ground.
- H. Provide each circuit with a dedicated breaker, and run wiring in its own conduit, separate from any control wiring. Connect the controller's ground wire to the electrical panel ground; conduit grounds are not acceptable.
- I. Surge Protection: Install surge protection according to manufacturer's instructions. Multiple controllers fed from a common power supply may be protected by a common surge protector, properly sized for the total connected devices.
- J. Grounding: Ground controllers and cabinets to a good earth ground as specified in Division 26.
- K. Conduit grounding is not acceptable; all grounding shall have a direct path to the building earth ground. Ground sensor drain wire shields at the controller end.
- L. The Contractor shall be responsible for correcting all associated ground loop problems.
- M. Run wiring in panel enclosures in covered wire track.

3.4 COMPONENT IDENTIFICATION LABELING

- A. Using an electronic hand-held label maker with white tape and bold black block lettering, provide an identification label on the exterior of each new control panel, control device, actuator, and sensor. Also provide labels on the exterior of each new control actuator indicating the (full) open and (full) closed positions. For labels located outdoors, use exterior grade label tape, and provide labels on both the inside and outside of the panel door or device cover. Acceptable alternatives are white plastic labels with engraved bold black block lettering permanently attached to the control panel, control device, actuator, and sensor. Have the labels and wording approved by the BAS Owner prior to installation

3.5 WARRANTY

- A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.
- B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this contractor at no expense to the Owner.

3.6 WARRANTY ACCESS

- A. The Owner shall grant to this contractor, reasonable access to the TCS and FMCS during the warranty period.
- B. The owner shall allow the contractor to access the BACS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.7 ACCEPTANCE TESTING

- A. Upon completion of the installation, this contractor shall load all system software and start-up the system. This contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these specifications.
- B. This contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.
- C. Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.
- D. System Acceptance: Satisfactory completion is when this contractor and the Division 26 contractor have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.8 OPERATOR INSTRUCTION, TRAINING

- A. During system commissioning and at such time acceptable performance of the BACS hardware and software has been established this contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.
- B. This contractor shall provide 24 hours of instruction to the owner's designated personnel on the operation of the BACS and describe its intended use with respect to the programmed functions specified. Operator orientation of the systems shall include, but not be limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the System's operation.
- C. The training shall be in three sessions as follows:
 - 1. Initial Training: One day session (8 hours) after system is started up and at least one week before first acceptance test. Manual shall have been submitted at least two weeks prior to training so that the owners' personnel can start to familiarize themselves with the system before classroom instruction begins.
 - 2. First Follow-Up Training: Two days (8 hours total) approximately two weeks after initial training, and before Formal Acceptance. These sessions will deal with more advanced topics and answer questions.
 - 3. Warranty Follow Up: Two days (8 hours total) in no less than 4 hour increments, to be scheduled at the request of the owner during the one year warranty period. These sessions shall cover topics as requested by the owner such as; how to add additional points, create and gather data for trends, graphic screen generation or modification of control routines.

END OF SECTION 230900

SECTION 230993 - SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section - Common Work Results
 - 2. Section 230900 – Direct Digital Control (DDC) System
 - 3. Other Sections – Equipment with built in DDC controllers.
 - 4. Division 23 Section - Testing, Adjusting, and Balancing
 - 5. Division 26
 - 6. Division 28

1.2 GENERAL

- A. As noted in Section 230900, the BACS modifications and upgrades are furnished and installed by XL Mechanical under separate contract with The Maine Turnpike Authority with work strictly coordinated under the scope of Division 23. This section is offered for reference and to document the control sequences to be employed under the BACS contract.
- B. Sequences specified herein apply to both new and existing equipment and systems within the facility. It shall be the responsibility of the BACS contractor to determine which, if any existing sensors, cabling, actuators, etc. may be re-used for operation with the new BACS. BACS contractor shall provide all required hardware, software, and programming for a complete operational system as specified herein.
- C. Control sequences are intended to be performance based. Implementations that provide the same functional result using different underlying detailed logic will be acceptable. As noted, control sequences shall be in accordance with ASHRAE Guideline 36-2021.
- D. All points shown in the points list or described in the sequence shall be shown on the graphics.
- E. All setpoints including setpoints internal to control algorithms shall be adjustable from all BAS operator interfaces. All commands shall be overridable from all BAS operator interfaces. All control points shall be adjustable or overridable from the same graphic page that displays the points.
- F. All points required by the sequence of operation including, but not limited to, the points listed in the sequences of operation below, as well as all of the points' associated values, shall be

connected to the BAS and available to the BAS operators on all operator workstations and all operator interface devices as part of a graphical display that depicts the mechanical system controlled.

- G. Unless otherwise indicated, control loops shall be enabled and disabled based on the status of the system being controlled to prevent windup.
- H. When a control loop is enabled or reenabled, it and all its constituents (such as the proportional and integral terms) shall be set initially to a neutral value.
- I. A control loop in neutral shall correspond to a condition that applies the minimum control effect, i.e., valves/dampers closed, VFDs at minimum speed, etc.
- J. When there are multiple OA temperature sensors, the system shall use the valid sensor that most accurately represents the OA conditions at the equipment being controlled.
- K. The term “control loop” or “loop” is used generically for all control loops. These will typically be PID loops, but proportional plus integral plus derivative gains are not required on all loops. Unless specifically indicated otherwise, the guidelines in the following subsections shall be followed.
 - 1. Use proportional only (P-only) loops for limiting loops (such as zone CO₂ control loops, etc.). Limiting loops are used to prevent controlled variables from rising above or dropping below setpoint (depending on the application) by defining a fixed threshold at which the loop output reaches 100%. Limiting loops shall use proportional-only control to prevent integral windup from causing the controlled sensor to overshoot setpoint due to the sensor generally being far from setpoint.
 - 2. Do not use the derivative term on any loops unless field tuning is not possible without it. Use of the derivative term makes loop tuning difficult in practice. It can make loops unstable because it increases as the rate of change of the error increases, amplifying the error signal. It is used in industrial process controls and systems that have to react quickly but is rarely if ever needed in HVAC system.
- L. When HVAC equipment or a sequence is specified to be started and stopped by a temperature, humidity, pressure setpoint or any other controlled variable, there shall be an adjustable differential setpoint that shall be set to prevent short cycling of the systems and equipment due to minor changes in the controlled variable.
- M. To avoid abrupt changes in equipment operation, the output of every control loop shall be capable of being limited by a user adjustable maximum rate of change, with a default of 25% per minute.
- N. All setpoints, timers, deadbands, PID gains, etc. listed in sequences shall be adjustable by the user with appropriate access level whether indicated as adjustable in sequences or not. Software points shall be used for these variables. Fixed scalar numbers shall not be embedded in programs except for physical constants and conversion factors.

- O. Provide minimum runtime timers for loads that are cycled to prevent over-cycling. Timers shall be set as specified or as needed to prevent damage or excessive wear to the equipment. Safeties shall override runtime timers.
- P. All setpoints, timers, deadbands, PID gains, etc. listed in sequences shall be adjustable by the user with appropriate access level whether indicated as adjustable in sequences or not. Software points shall be used for these variables. Fixed scalar numbers shall not be embedded in programs except for physical constants and conversion factors.
- Q. Values for all points, including real (hardware) points used in control sequences shall be capable of being overridden by the user with appropriate access level (e.g., for testing and commissioning). If hardware design prevents this for hardware points, they shall be equated to a software point, and the software point shall be used in all sequences. Exceptions shall be made for machine or life safety.
 - 1. All hardware points, not just inputs, shall be capable of being overridden for purposes of testing and commissioning. For example, the commissioning agent shall be able to command damper positions, valve positions, fan speeds, etc. directly through BAS overrides.
 - 2. The requirement to equate hardware points to software points is necessary for systems that do not allow overriding real input points.
 - 3. The user interface shall allow the user to set an expiration period that automatically releases the override after the period has expired. The system shall also keep track of who initiates each override and when.
- R. Provide Sequenced starting of HVAC equipment at initial startup, whether or not specifically mentioned in each Sequence of Operation.
- S. All setpoints indicated in the control specification are to be adjustable. The setpoints indicated herein are only specified as a calculated starting point (or initial system operation). It is expected that setpoint adjustments and control loop tuning shall be required to provide optimum system operation based on the requirements of the building. The control contractor shall work with the TAB contractor (230593) and the Owner to provide the final system setpoint adjustments and control loop tuning after the system is in operation and building is in use.
- T. BACnet
 - 1. All controllers with BACnet cards shall be integrated into the DDC system via BACnet. Provide DDC programming to define input and output information available through the boiler manufacturer's integration data port.
 - 2. All hardwired points and any setpoints, timers, or other control elements that are specified to be adjustable (adj.) shall be mapped as BACnet objects and be available on the user interface to be adjusted.
- U. Trends shall be provided for all hardware I/O points and integrated points listed as having trending and for analog and binary data points mapped to the user interface. Interval trending with sample intervals of 10 minutes shall be provided on analog process variables (this includes both analog inputs and calculated process variables) and process outputs. Data shall be stored at

the supervisory controller or in the field controller and uploaded to the DDC system server when archiving is desired. Consult with the Owner to determine which trends should be archived. Trending shall be in place for a minimum of 24 hours prior to functional testing by the commissioning provider. The BAS shall sample and store trend data and shall be able to archive data to the hard disk.

V. Point Types

1. AO = analog output
2. DO = digital output (also, BO = binary output)
3. AI = analog input
4. DI = digital input (aka BI = Binary Input)

1.3 ALARMS

- A. Provide alarms per ASHRAE Guideline 36, Paragraph 5.1.12: "Alarms".
- B. Provide at least the following requirements in the specification for the BAS graphical user interface:
 1. All alarms shall include a time/date stamp using the standalone control module time and date.
 2. Each alarm can be configured in terms of level, latching (Requires Acknowledgment of a Return to Normal).
 3. Normal/Does Not Require Acknowledgment of a Return to Normal), entry delay, exit deadband, and post-suppression period.
 4. An operator shall be able to sort alarms based on level, time/date, and current status. Alarms should be reported with the following information:
 - a. Date and time of the alarm
 - b. Level of the alarm
 - c. Description of the alarm
 - d. Equipment tags for the units in alarm.
 - e. Possible causes of the alarm if provided by the fault detection routines.
 - f. The source that serves the equipment in alarm, per ASHRAE Guideline 36, Paragraph 5.1.19 "Hierarchical Alarm Suppression".
- C. As per ASHRAE Guideline 36, there shall be 4 levels of alarm:
 1. Level 1: Life-safety message
 2. Level 2: Critical equipment message
 3. Level 3: Urgent message
 4. Level 4: Normal message
- D. Alarms shall be reset during a power failure; the controls shall be programmed to ignore alarms that will occur upon loss of power. For example, a pump status alarm is not necessary, since it's obvious that the pump will fail upon loss of power.

- E. Alarms associated with equipment that is disabled shall be inhibited.
- F. Current status switches shall prove the operation of fans and pumps. Level 2 Alarm, Fans & pumps: Status point not matching it's on/off point for 3 seconds after a time delay of 15 seconds while the equipment is commanded on. The term "proven" (i.e., "prove ON"/ "prove OFF") shall mean that the equipment's DI status point (current switch) matches the state set by the equipment's DO command point.
- G. If an operating equipment has any fault condition, a Level 2 alarm shall be generated, and a response shall be triggered as defined in ASHRAE Guideline 36.

1.4 TRIM & RESPOND (T&R) SET-POINT RESET LOGIC

- A. Provide T&R logic per ASHRAE Guideline 36, Paragraph 5.1.14: "Trim & Respond Set-Point Reset Logic".
- B. Trim & Respond logic shall reset the setpoint within the range minimum (SPmin) to maximum (SPmax) setpoint. When the associated device is OFF, the setpoint shall be SP0.
- C. T&R logic resets a setpoint for pressure, temperature, or other variables. It reduces the setpoint at a fixed rate until a downstream zone is no longer satisfied and generates a request. When a sufficient number of requests are present, the setpoint is increased in response. The importance of each zone's requests can be adjusted to ensure that critical zones are always satisfied. When a sufficient number of requests no longer exist, the setpoint resumes decreasing at its fixed rate. A running total of the requests generated by each zone is kept identifying zones that are driving the reset logic.

PART 2 - SEQUENCES

2.1 BASIS OF DESIGN

- A. Design Setpoints.

Type of Area	Winter DB	Summer DB
Office	70°F	72°F
Corridor	70°F	74°F
Conference Room	70°F	72°F
Other, if not listed	70°F	75°F

- B. Heating systems shall be equipped with controls configured to automatically restart and temporarily operate the system as required to maintain zone temperatures above an adjustable heating setpoint down to 55°F.

C. Cooling systems shall be equipped with controls configured to automatically restart and temporarily operate the mechanical cooling system as required to maintain zone temperatures below an adjustable cooling setpoint up to 85°F or to prevent high space humidity levels.

2.2 TERMINAL UNITS – COMMON REQUIREMENTS

A. Control sequence specified herein applies to new, existing, and relocated terminal units.

B. Each zone shall have separate occupied and unoccupied heating and cooling setpoints.

C. The active setpoints shall be determined by the operating mode of the Zone Group. Zone scheduling groups, or Zone Groups, are sets of zones served by a single air handler that operate together for ease of scheduling and/or in order to ensure sufficient load to maintain stable operation in the upstream equipment.

1. The set points shall be the occupied set points during occupied mode, warm-up mode, and cooldown mode.
2. The set points shall be the unoccupied set points during unoccupied mode, setback mode, and setup mode.

D. The software shall prevent the following:

1. The heating setpoint from exceeding the cooling setpoint minus 1°F (i.e., the minimum difference between heating and cooling setpoints shall be 1°F).
2. The unoccupied heating setpoint from exceeding the occupied heating setpoint.
3. The unoccupied cooling setpoint from being less than the occupied cooling setpoint.

E. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.

1. The adjustment shall be capable of being limited in software.
 - a. As a default, the active occupied cooling setpoint shall be limited between 73°F and 80°F.
 - b. As a default, the active occupied heating setpoint shall be limited between 65°F and 72°F.
2. The active heating and cooling setpoints shall be independently adjustable, respecting the limits and anti-overlap logic. If zone thermostat provides only a single set-point adjustment, then the adjustment shall move both the active heating and cooling setpoints upward or downward by the same amount.
3. The adjustment shall only affect occupied setpoints in Occupied Mode, Warmup Mode, and Cooldown Mode and shall have no impact on setpoints in all other modes.

F. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time (60 minutes, adj.). At the expiration of this time, control of the unit shall automatically return to the schedule.

G. Control Loops

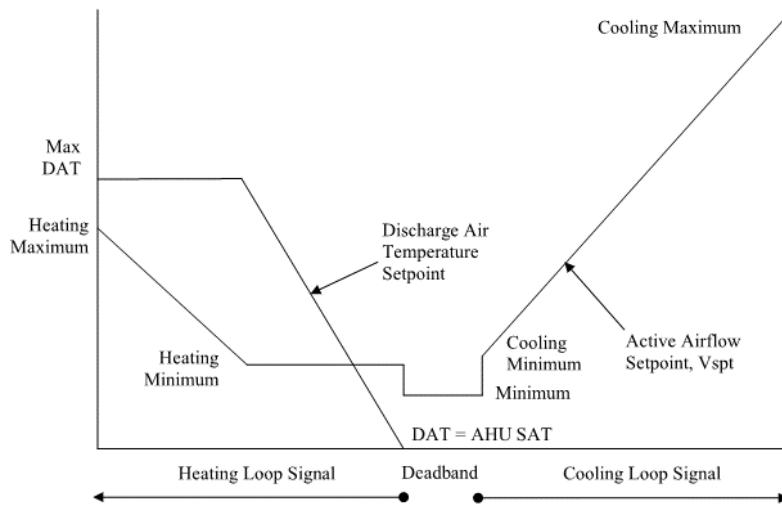
1. Two separate control loops, the Cooling Loop, and the Heating Loop, shall operate to maintain space temperature at setpoint.
 - a. The Heating Loop shall be enabled whenever the space temperature is below the current zone heating set-point temperature and disabled when space temperature is above the current zone heating setpoint temperature, and the loop output is zero for 30 seconds. The loop may remain active at all times if provisions are made to minimize integral windup.
 - b. The Cooling Loop shall be enabled whenever the space temperature is above the current zone cooling set-point temperature and disabled when space temperature is below the current zone cooling set-point temperature and the loop output is zero for 30 seconds. The loop may remain active at all times if provisions are made to minimize integral windup.
2. The Cooling Loop shall maintain the space temperature at the active cooling setpoint. The output of the loop shall be a software point ranging from 0% (no cooling) to 100% (full cooling).
3. The Heating Loop shall maintain the space temperature at the active heating setpoint. The output of the loop shall be a software point ranging from 0% (no heating) to 100% (full heating).
4. Loops shall use proportional + integral logic or other technology with similar performance. Proportional-only control is not acceptable, although the integral gain shall be small relative to the proportional gain. P and I gains shall be adjustable by the operator.
5. See other sections for how the outputs from these loops are used.

H. Zone Temperature Alarms

1. High-temperature alarm
 - a. If the zone is 3°F above cooling setpoint for 10 minutes, generate a Level 4 alarm.
 - b. If the zone is 5°F above cooling setpoint for 10 minutes, generate a Level 3 alarm.
2. Low-temperature alarm
 - a. If the zone is 3°F below the heating setpoint for 10 minutes, generate a Level 4 alarm.
 - b. If the zone is 5°F below the heating setpoint for 10 minutes, generate a Level 3 alarm.
3. Suppress zone temperature alarms as follows:
 - a. After zone setpoint is changed.
 - b. While Zone Group is in Warmup Mode or Cooldown Mode.

2.3 VAV TERMINAL UNITS

- A. VAV Terminal Unit with Reheat Active endpoints used in the control logic depicted in Figure 5.6.5 shall vary depending on the mode of the Zone Group the zone is a part of (see Table 5.6.4).
- B. Provide VAV Terminal Unit with Reheat Control logic as shown in Figure 5.6.5 and described in the following subsections.



C. **Figure 5.6.5 Control logic for VAV reheat zone.**

Table 5.6.4 Endpoints as a Function of Zone Group Mode

Endpoint	Occupied	Cooldown	Setup	Warmup	Setback	Unoccupied
Cooling maximum	Vcool-max	Vcool-max	Vcool-max	0	0	0
Cooling minimum	Vmin*	0	0	0	0	0
Minimum	Vmin*	0	0	0	0	0
Heating minimum	Max (Vheat-min, min*)	Vheat-min	0	Vheat-max	Vheat-max	0
Heating maximum	Max (Vheat-max, min*)	Vheat-max	0	Vcool-max	Vcool-max	0

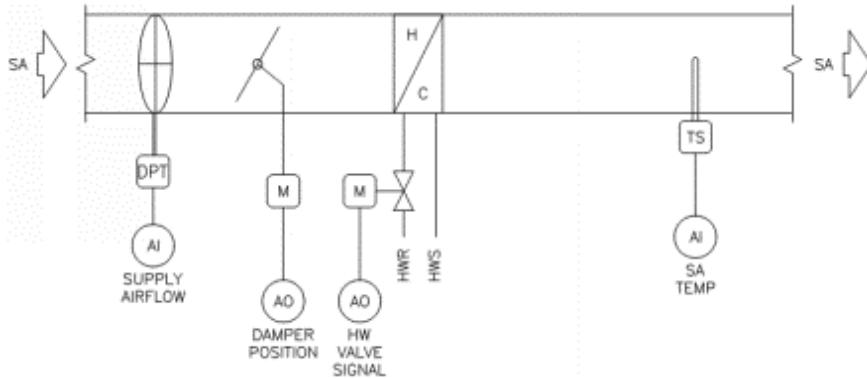
D.

1. When the Zone State is cooling, the cooling-loop output shall be mapped to the active airflow setpoint from the cooling minimum endpoint to the cooling maximum endpoint. Heating coil is disabled unless the DAT is below the minimum setpoint (50°F).
 - a. If SA temperature from the air handler is greater than room temperature, the active airflow setpoint shall be no higher than the minimum endpoint.
2. When the Zone State is deadband, the active airflow setpoint shall be the minimum endpoint. Heating coil is disabled unless the DAT is below the minimum setpoint (50°F).
3. The purpose of the following heating sequence is to minimize the reheat energy consumption by first increasing the SAT while maintaining minimum flow, and only

increasing the total airflow if needed to satisfy the zone: When the Zone State is heating, the Heating Loop shall maintain space temperature at the heating setpoint as follows:

- a. From 0% to 50%, the heating-loop output shall reset the discharge temperature setpoint from the current AHU SAT setpoint to a maximum of $\text{Max}\Delta T$ above space temperature setpoint. The active airflow setpoint shall be the heating minimum endpoint.
- b. From 51% to 100%, if the DAT is greater than room temperature plus 5°F, the heating loop output shall reset the active airflow setpoint from the heating minimum endpoint to the heating maximum endpoint.
- c. The heating coil shall be modulated to maintain the discharge temperature at setpoint. (Directly controlling heating off the zone temperature control loop is not acceptable).

4. In Occupied Mode, the heating coil shall be modulated to maintain a DAT no lower than 50°F.
5. The VAV damper shall be modulated by a control loop to maintain the measured airflow at the active setpoint.



E. VAV Alarms: Provide per Guideline 36 Paragraph 5.6.6.

1. Low Airflow
2. Low-SA Temperature
3. Airflow Sensor Calibration. If the fan serving the zone is OFF and airflow sensor reading is above the larger of 10% of the cooling maximum airflow setpoint or 50 cfm for 30 minutes, generate a Level 3 alarm.
4. Leaking Damper. If the damper position is 0%, and airflow sensor reading is above the larger of 10% of the cooling maximum airflow setpoint or 50 CFM for 10 minutes while the fan serving the zone is proven ON, generate a Level 4 alarm.
5. Leaking Valve. If the valve position is 0% for 15 minutes, DAT is above AHU SAT by 5°F, and the fan serving the zone is proven ON, generate a Level 4 alarm.

F. VAV Testing/Commissioning Overrides. Provide software switches that interlock to a system level point to:

1. force zone airflow setpoint to zero,
2. force zone airflow setpoint to Vcool-max,
3. force zone airflow setpoint to Vmin,
4. force zone airflow setpoint to Vheat-max,
5. force damper full closed/open,
6. force heating to OFF/closed, and
7. reset request-hours accumulator point to zero (provide one point for each reset type listed in the next section).

G. VAV System Requests

1. Cooling SAT Reset Requests
 - a. If the zone temperature exceeds the zone's cooling setpoint by 5°F for 2 minutes and after suppression period due to setpoint change, send 3 requests.
 - b. Else if the zone temperature exceeds the zone's cooling setpoint by 3°F for 2 minutes and after suppression period due to setpoint change, send 2 requests.
 - c. Else if the Cooling Loop is greater than 95%, send 1 request until the Cooling Loop is less than 85%.
 - d. Else if the Cooling Loop is less than 95%, send 0 requests.
2. Static Pressure Reset Requests
 - a. If the measured airflow is less than 50% of setpoint while setpoint is greater than zero and the damper position is greater than 95% for 1 minute, send 3 requests.
 - b. Else if the measured airflow is less than 70% of the setpoint while the setpoint is greater than zero and the damper position is greater than 95% for 1 minute, send 2 requests.
 - c. Else if the damper position is greater than 95%, send 1 request until the damper position is less than 85%.
 - d. Else if the damper position is less than 95%, send 0 requests.
3. If There Is a Hot-Water Coil, Hot-Water Reset Requests
 - a. If the DAT is 30°F less than the setpoint for 5 minutes, send 3 requests.
 - b. Else if the DAT is 15°F less than the setpoint for 5 minutes, send 2 requests.
 - c. Else if HW valve position is greater than 95%, send 1 request until the HW valve position is less than 85%.
 - d. Else if the HW valve position is less than 95%, send 0 requests.
4. If There Is a Hot-Water Coil and Heating Hot-Water Plant Requests. Send the heating hot-water plant that serves the zone a heating hot-water plant request as follows:
 - a. If the HW valve position is greater than 95%, send 1 request until the HW valve position is less than 10%.
 - b. Else if the HW valve position is less than 95%, send 0 requests.

- H. For VAV zones with CO2 sensors: When in the occupied mode, the controller shall measure the zone CO2 concentration and modulate the zone damper open on rising CO2 concentrations, overriding normal damper operation to maintain a CO2 setpoint of not more than 750 ppm (adj.).
- I. For zones with associated perimeter heating, modulate electronic control perimeter heating HW valve in sequence (simultaneously) with reheat coil to maintain space temperature when associated AHU is running. When space temperature is below setpoint modulate the HW valve open. The reverse shall occur when space temperature is above setpoint. When the associated AHU is off, the radiation valve shall be modulated to maintain heating setpoint and the associated reheat valve shall be closed. Close the perimeter heating valve closed whenever OA is above 50° F (adj.).

END OF SECTION 230993

SECTION 232113 – HYDRONIC HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results"
 - 2. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories.
 - 3. Division 23 controls section for temperature-control valves and sensors.

1.2 SUMMARY

- A. This Section includes piping and specialties for hydronic HVAC piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping
 - 2. Hydronic specialties
 - 3. Chemical treatment.
- B. Delegated-Design Submittal: Braided Expansion Loops
 - 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.

1.4 INFORMATIONAL SUBMITTALS

- A. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Qualify soldering processes, procedures, and solderers for copper and copper alloy pipe and tube in accordance with ASTM B 828.
- C. Qualify brazing processes for copper and copper alloy pipe and tube according to ANSI/AWS C3.4.
- D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
- E. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.7 COORDINATION

- A. Drawings show the general layout of piping and accessories but do not show all required fittings and offsets that may be necessary to connect piping to equipment and to coordinate with other trades. Fabricate piping based on field measurements. Provide all necessary fittings and offsets.
- B. Coordinate layout and installation of hydronic piping and suspension system components with other construction.
- C. Coordinate pipe sleeve installations and penetrations with other trades.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Balancing Valves:

- a. Griswold Controls.
- b. ITT Bell & Gossett
- c. Taco, Inc.
- d. Tour & Anderson
- e. IMI Flow Design
- f. Griswold Controls
- g. Watts Industries Inc.
- h. Caleffi
- i. Nexus

2. Hydronic Pressure-Reducing Valves:

- a. Amtrol, Inc.
- b. Armstrong Pumps, Inc.
- c. Conbraco Industries, Inc.
- d. ITT Bell & Gossett
- e. Spence Engineering Company, Inc.
- f. Caleffi
- g. Watts Industries, Inc.

3. Safety Valves:

- a. Amtrol, Inc.
- b. Armstrong Pumps, Inc.
- c. Conbraco Industries, Inc.
- d. ITT McDonnell & Miller.
- e. Kunkle Valve Division.
- f. Spence Engineering Company, Inc.
- g. Caleffi
- h. Watts Industries Inc.

4. Air Vents and Vacuum Breakers:

- a. Armstrong International, Inc.
- b. Barnes & Jones, Inc.
- c. ITT Hoffman
- d. Caleffi
- e. Spirotherm
- f. Spirax Sarco, Inc.

2.2 PIPING MATERIALS

A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. DWV Copper Tubing: ASTM B 306, Type DWV.
- C. Fitting Standard: Copper fittings shall conform to ASME B16.18, ASME B16.22 or ASME B16.26.
- D. Press Fitting: Viega Pro Press - Copper and copper alloy press fittings shall conform to material requirements of ASME B16.18 or ASME B16.22 and performance criteria of IAPMO PS 117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have SC (Smart Connect) feature design (leakage path). Provide a smart connect feature to assure leakage of liquids and/or gases from inside the system past the sealing element of an un-pressed connection. The function of this feature shall be to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.
- E. Wrought-Copper Unions: ASME B16.22.
- F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 and Smaller: ASTM A-53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40 and 80, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 and larger: ASTM A-53, Type E (electric-resistance welded), Grade B, Schedule 40 and 80, black steel, plain ends.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
- 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: Material Group: 1.1. End Connections: Butt-welding. Facings: Raised face.
- H. Mechanically formed copper or steel tee connections are not acceptable.

- I. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ANSI B16.11 may be used for drain, vent and gage connections.
- J. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- K. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.5 HYDRONIC VALVES

- A. Gate Valves
 - 1. Threaded Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising-stem, solid wedge: Hammond IB617, Nibco T-124/134, Stockham B105, Milwaukee 1152 or equal.
 - 2. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, bolted bonnet, rising stem, OS&Y, solid wedge: Hammond IR1140, Nibco F617-0, Stockham G623, Milwaukee F2885 or equal.
 - 3. Solder Ends 2" and Smaller: Class 125, bronze body, union bonnet, rising-stem, solid wedge: Hammond IB648, Nibco S134, Stockham B115, Milwaukee 1169 or equal.
 - 4. Comply with the following standards: Cast Iron Valves: MSS SP – 70; Bronze Valves: MSS SP – 80.
- B. Ball Valves
 - 1. Threaded Ends 4" and Smaller: 150 psi WP and 600 psi non-shock CWP, forged brass full-port or cast bronze two-piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem: Watts FBV-3C series/B6080 series, Hammond 8501, Nibco T-585-70, Milwaukee BA100, Apollo 70-Series, or approved equal.
 - 2. Soldered Ends 3" and Smaller: 150 psi WP and 600psi non-shock CWP, full-port cast bronze or forged brass two piece body, hard chrome plated forged brass ball, true adjustable packing nut ("O"-ring only type stem seal not acceptable), blow-out proof stem: Watts FBVS-3C series/B6081 series, Hammond 8511, Nibco S-585-70, Milwaukee BA150, Apollo 70-Series, approved or equal.
 - 3. Comply with MSS SP-110.
- C. Butterfly Valves
 - 1. Basis of Design: Center Line Series 200; Lug Type, cast iron, drilled and tapped lug body, ductile iron disc, 416SS shaft, bronze bushing, EPDM seat.
 - 2. Valve bodies shall have extended necks to provide for 2-1/4" insulation as needed.
 - 3. Comply with MSS SP-67.
 - 4. Compatible with ANSI 125/150 flanges. Dead-end capacity to 200 psi.

5. Operators: 6" and smaller: handle with infinite adjustment; 8" and larger: gear w/balance-stop hand wheel. Valves located 7 feet or higher: provide gear/chain wheel.
6. Approved Manufacturers: Watts, Hammond, Nibco, Milwaukee, or approved equal.

D. Bronze Globe Valves, Class 125:

1. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded or solder joint.
- e. Stem and Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron.

E. Bronze Globe Valves, Class 150:

1. Description:

- a. Standard: MSS SP-80, Type 2.
- b. CWP Rating: 300 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
- d. Ends: Threaded.
- e. Stem: Bronze.
- f. Disc: Bronze.
- g. Packing: Asbestos free.
- h. Handwheel: Malleable iron.

F. Iron Globe Valves, Class 125:

1. Description:

- a. Standard: MSS SP-85, Type I.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM A 126, gray iron with bolted bonnet.
- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Packing and Gasket: Asbestos free.
- g. Operator: Handwheel or chainwheel.

G. Iron Globe Valves, Class 250:

1. Description:

- a. Standard: MSS SP-85, Type I.
- b. CWP Rating: 500 psig.
- c. Body Material: ASTM A 126, gray iron with bolted bonnet.

- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Packing and Gasket: Asbestos free.
- g. Operator: Handwheel or chainwheel.

H. Wafer Check valves: Provide wafer style, butterfly type, spring actuated check valves designed to be installed with gaskets between two standard Class 125 flanges. Construct iron body valves with pressure containing parts of valves with materials conforming to ANSI/ASTM A 126, Grade B. Support hanger pin by removable side plug; Class 125, cast iron body, stainless steel trim, bronze disc, Buna-N seal; Watts BF/DBF series, Metraflex 700 Series, Nibco W920-W, Stockham WG970, Hammond 9253, Milwaukee 1400, or approved or equal.

I. Swing check valves:

- 1. Construct pressure containing parts of Valves as follows: Bronze Valves: 125 or 150 psi: ANSI/ASTM B 62; Iron Body Valves: ANSI/ASTM A-126, Grade B. Comply with the following standards for design, workmanship, material and testing: Bronze Valves: MSS SP – 80; Cast Iron Valves: MSS SP – 71.
- 2. Construct valves of pressure casting free of any impregnating materials. Construct disc and hanger as one piece. Support hanger pins by removable side plug.
- 3. Threaded Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB904, Nibco T-413Y, Stockham B320T, Milwaukee 509 or approved equal.
- 4. Soldered Ends 2" and Smaller: Class 125, bronze body, screwed cap, Teflon disc: Hammond IB912, Nibco S-413-Y, Stockham B310T, Milwaukee 511 or approved equal.
- 5. Flanged Ends 2-1/2" and Larger: Class 125, iron body, bronze mounted, horizontal swing, cast-iron disc: Hammond IR1124, Nibco F918-B, Stockham G931, Milwaukee F2974 or approved equal.

2.6 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

B. Automatic Air Vent: Spirotherm Spirotop, or equal; maintenance-free, designed to vent automatically with float principle; solid-brass body and nonferrous internal parts; 150-psig working pressure; 270°F maximum temperature; NPS 1/2 inlet connection; 1/2" male thread at vent point for pressure-testing or remote venting of unwanted gases. The Spirotop has a unique "dry" vent design that helps prevent the system fluid from reaching the spring actuated Viton seat and seal assembly, which is the cause of most conventional air vent failures. Air vent shall be dry: release air, not water.

- 1. The unique valve mechanism is guaranteed not to leak and cannot be shut off.
- 2. Specially constructed air chamber to protect the valve mechanism from dirt.
- 3. Sufficient volume to handle pressure fluctuations.
- 4. A reliable vacuum breaker for system draining.
- 5. Leak and dirt resistant.

2.7 HOOKUPS AND BALANCING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following.
 - 1. Nexus (Basis of Design)
 - 2. IMI Flow Design
 - 3. HCI
 - 4. Hays
 - 5. Griswold
 - 6. Victaulic
 - 7. Taco
 - 8. Bell & Gossett
- B. Minimum Requirements Per Coil Installation:
 - 1. Manual Flow Control Valve (MFCV)
 - 2. Y-strainer.
 - 3. Temperature Control Valve (TCV) – see 230900.
 - 4. Union connections at coil and TCV.
 - 5. Air vent on return side.
 - 6. Blowdown/drain valve on supply side.
 - 7. Pressure/temperature test plugs across coil and TCV.
 - 8. Full port, union end ball valves or butterfly valve for shutoff.
- C. Materials Of Construction (2½" and smaller, except as noted)
 - 1. Brass or stainless steel metals.
 - 2. Teflon, EPDM or FKM seals.
- D. Installation
 - 1. Installation shall conform to basic piping methods specifications.
 - 2. All components shall be isolated by shutoff valves.
 - 3. Flexible hoses shall be installed at coil connections as shown in the plans or at the option of the mechanical contractor.
 - 4. Union tailpieces may be used to reduce pipe sizes to match coil and TCV valve sizes.
 - 5. Pressure/Temperature test plugs shall be installed across coil.
 - 6. A Y-strainer or combination strainer and valve shall be installed on the supply side.
 - 7. Unions shall be used to isolate the coil, AFCV and TCV.
- E. Shutoff Valves (2½" and smaller) shall be forged brass ball valves, Nexus Model UX:
 - 1. A one-piece body rated at 250 psi WP, 325° F.
 - 2. Interchangeable union ends with FKM O-ring seal (ground joint is not acceptable).
 - 3. Multiple ¼" tapped ports for test plugs, vent, and/or drain.
 - 4. Blowout-proof stem with dual KFM O-ring seals.
 - 5. Hard chrome plated stainless steel ball with Teflon seats.

F. Shutoff Valves (2½" and larger) shall be lug pattern butterfly valves, Nexus Model BV:

1. A minimum of 225 psi WP, 250° F.
2. 125# Class lug pattern cast or ductile iron body.
3. EPDM cartridge seat, 416 stainless steel one-piece shaft, and 304 stainless steel disc.
4. Top and bottom shaft bushings.
5. Provide an infinite position chrome plated steel top plate for balancing purposes.
6. Epoxy coated body.

G. Manual Flow Control Valves (2½" and smaller) shall be a combination of metering/balance type of forged brass construction, Nexus Model XB:

1. A modified venturi equipped with (2) pressure/temperature ports and an ID tag.
2. A combination shutoff and memory stop device-indicating degree of opening.
3. A rating of 250 WOG, 325°F.
4. An interchangeable union ends with FKM O-ring type seal.
5. Blowout proof stem with dual FKM O-ring seals.
6. Hard chrome plated stainless steel ball with Teflon seats.

H. Manual Flow Control Valves (2½" and larger) shall be an instrument and metering station with integral Pitot Tube, multiple ports for instruments, accessories and drains, a butterfly throttling valve; Nexus Model NXFB:

1. The Pitot tube shall be twin tube design, of 316 stainless steel with blowout proof attachment to station body.
2. Ports shall include ¾" port for thermometer well, ¼" ports for pressure gauge, air vent, transmitter or other accessories, and a ½" drain port.
3. The instrument station shall be 125# Class flanged (mates to 150# Class flanges) construction.
4. The butterfly valve shall be lug pattern with a rating 225 PSIG, 250°F.
The butterfly valve shall have an infinite position operator with memory stop (6" and smaller), worm gear with memory stop (6" and larger).

I. Temperature Control Valves, ref. Section 230900 & 230993.

J. Combination Strainer/Ball Valves (2½" and smaller) used for supply side shutoff and strainer requirements shall be forged brass construction, Nexus Model UY:

1. A minimum rating of 250 WOG, 325° F.
2. Interchangeable union end with FKM O-ring seal.
3. Multiple ¼" tapped ports for test plugs, vent, or other accessories.
4. Blowout proof stem with dual FKM O-ring seals.
5. Hard chrome plated stainless steel ball with Teflon seats.
6. A 20 mesh 304 stainless steel filter screen, accessible without affecting the valve piping.
7. A port in the filter cap for a blowdown/drain valve.

K. Combination Strainer/Butterfly Valves (2½" and larger) used for supply side shutoff and strainer requirements shall be cast or gray iron construction, Nexus Model SXFV:

1. A minimum rating of 175 psi WP, 250° F.
2. 125# Class flanges (mates to 150# Class flanges) and lug pattern butterfly valve.
3. Multiple $\frac{1}{4}$ " tapped accessory ports across the filter screen.
4. A flanged end cap with a $\frac{3}{4}$ " port for a blowdown/drain valve standard thru 8" size.
5. A $\frac{3}{4}$ " port for thermometer well.
6. A 304 stainless steel screen, with perforations 0.045" thru 3", and 0.125" thru 8".

L. Y-Strainers (2 $\frac{1}{2}$ " and smaller) shall be forged brass body, Nexus Model UYX:

1. $\frac{1}{4}$ " tapped accessory ports.
2. A rating of 250 WOG, 325° F.
3. A 20 mesh 304 stainless steel filter screen, removable without affecting the strainer piping.
4. A port in the filter cap for a blowdown/drain valve.

M. Y-Strainers (2 $\frac{1}{2}$ " and larger) shall be 125# Class flanged cast or ductile iron body, Nexus Model SXF:

1. Multiple $\frac{1}{4}$ " tapped accessory ports across the filter screen.
2. A flanged end cap with a $\frac{3}{4}$ " port for a blowdown valve standard thru 8" size.
3. A $\frac{3}{4}$ " port for thermometer well.
4. A 304 stainless steel screen, with perforations 0.045" thru 3", and 0.125" thru 8".

N. Blowdown/Drain Valves shall be forged brass ball valve construction, Nexus Model BD:

1. A minimum rating of 250 WOG, 325° F.
2. Blowout proof stem with dual FKM O-ring seals.
3. Hard chrome plated brass ball with Teflon seats.
4. A $\frac{3}{4}$ " hose end and nylon / brass cap with retainer to protect threads.

O. Unions (2" and smaller) shall be forged brass, Nexus Model UU:

1. A minimum of 250 psi WP, 325° F.
2. Multiple $\frac{1}{4}$ " tapped ports for test plugs, vent and/or drain valves.
3. FKM O-ring seal.

P. Accessories to coil piping components shall conform to the following:

1. Nexus PT Pressure/Temperature test plugs shall be rated for 1000 psi, 325° F, with brass body, Nordel check plugs, and sealed cap.
2. Flexible hoses shall be designed for water, and fire retarding conform to ASTM codes E84-00, with stainless steel outer braid.
3. Hoses ($\frac{1}{2}$ " thru 1"), Nexus UFHF.
 - a. Shall have a Kevlar reinforced EPDM tube core, brass end fittings, and designed for a working pressure of 400 psi, 248°F.

- b. Provide dual union or swivel end fittings.
- 4. Hoses (1½" thru 2"), Nexus UFHM:
 - a. Shall have Rayon reinforced EPDM tube core, brass end fittings, and designed for a working pressure of 300 psi, 248° F. The (2½") hose shall have stainless steel outer braid and carbon steel Sch. 40 fittings, and designed for a working pressure of 400 psi, 70° F.
 - b. Provide least one union or swivel end fitting
- 5. Nexus MV Manual air vents shall be of brass construction and rated at 250 psi, 450° F.
- 6. Shaft extensions (2" and smaller) for insulated pipe shall be at least 2¼" tall and constructed of brass
- 7. Chilled water systems: Provide extended pressure and temperature test plugs, manual air vents and handles. Extended handles shall not break the vapor barrier when operated.
- 8. Provide a temperature and pressure test/meter kit (Nexus #MKA) for use by MC during start-up, turn-over to Owner at project completion.

2.8 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Peterson Equipment Co., Inc.
 - 2. Flow Design, Inc.
 - 3. Trerice, H. O. Co.
 - 4. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - 5. Weiss Instruments, Inc.
- B. Description: "Pete's Plug II", a ¼" fitting to receive either a temperature or pressure probe 1.8" OD.
- C. Body: Solid brass with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping. Core Inserts: Nordel, an ethylene-propylene based synthetic rubber.
- D. Minimum Pressure and Temperature Rating: 500 PSIG at 275 deg F.

2.9 WATER TREATMENT FOR CLOSED LOOP HYDRONIC SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Sentinel
 - 2. Anderson Chemical Company.
 - 3. Aqua-Chem, Inc.
 - 4. Barclay Water Management, Inc.
 - 5. General Electric Company; GE Water & Process Technologies.

6. H-O-H Water Technology, Inc.
7. Metro Group, Inc. (The); Metropolitan Refining Div.
8. Nalco; an Ecolab company.
9. Watcon, Inc.

B. Performance Requirements

1. Provide water treatment for closed-loop hydronic systems.
2. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
3. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
4. Closed hydronic systems, including shall have the following water qualities:
 - a. pH: Maintain a value within 8.2 to 9.5.
 - b. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - c. Total Hardness : <150 ppm as CaCO_3 .
 - d. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
 - e. Soluble Copper: Maintain a maximum value of 0.20 ppm.
 - f. TSS: Maintain a maximum value of 10 ppm.
 - g. Ammonia: Maintain a maximum value of 20 ppm.
 - h. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
 - i. Microbiological Limits:
 - 1) Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
 - 2) Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
 - 3) Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
 - 4) Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
 - 5) Iron Bacteria: Maintain a maximum value of zero organisms/mL.

PART 3 - EXECUTION

3.1 HYDRONIC PIPING APPLICATIONS – ABOVE GROUND

- A. Hot Water, NPS 3 and Smaller: Type L drawn-temper copper tubing with pressed or soldered joints; Schedule 40 steel pipe with threaded joints.
- B. Chilled Water, NPS 3 and Smaller: Type L drawn-temper copper tubing with soldered joints.

3.2 VALVE APPLICATIONS

- A. Hydronic Valve Applications: Shutoff Duty: Ball and butterfly valves. Throttling Duty: Globe, ball, and butterfly valves.
- B. Provide shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line.
- C. Provide calibrated balancing valves in the return water line of terminal units, as indicated, and as required to facilitate system balancing.
- D. Provide pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.3 HYDRONIC PIPING INSTALLATIONS

- A. Refer to Division 23 Section "Common Work Results" for installation of:
 - 1. Basic piping requirements.
 - 2. Joint construction requirements.
 - 3. Hanger, support, and anchor devices.
 - 4. Firestopping
 - 5. Sleeves and Escutcheons
 - 6. Dielectric fittings
 - 7. Valves
 - 8. Mechanical Identification
- B. Hydronic piping systems shall be provided to permit the system to be drained. Provide drains, consisting of a tee fitting, NPS 3/4 ball valve, and hose-end fitting with cap, at low points in piping system mains and elsewhere as required for system drainage.
- C. Provide piping at a uniform grade of 0.2 percent upward in direction of flow. Pipe size at connections to equipment shall be distribution main size, not connection size. Reduce pipe sizes using eccentric reducer fitting installed with level side up. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.
- D. Provide safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Provide safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements. Check the settings and operation of each safety valve, including valves furnished by heater manufacturer. Record settings.
- E. Swing Connections for Expansion: Connect risers and branch connections to mains with at least five pipe fittings, including tee in main. Connect mains and branch connections to terminal units with flexible hoses at least four pipe fittings, including tee in main.

F. Terminal Equipment Connections

1. Size for supply and return piping connections shall be same as for equipment connections.
2. Provide control valves in accessible locations close to connected equipment.
3. Arrange piping with offsets to allow for expansion, as well as terminal unit removal.

3.4 HYDRONIC SPECIALTIES INSTALLATION

A. Provide air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

3.5 CONTROL VALVE INSTALLATION

A. Perform the following as directed by the BAS contractor:

1. Provide modulating control valves with minimum of 10 pipe diameters straight pipe at inlet and 5 pipe diameters straight pipe at outlet.
2. Installation of immersion wells and pressure tappings, along with associated shut-off cocks.
3. Installation of flow switches.
4. Setting of automatic control valves or other control devices.

B. Valve submittals shall be coordinated for type, quantity, size, and piping configuration to ensure compatibility with pipe design.

C. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.

3.6 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the water characteristics described in Part 2.

B. Provide bypass chemical feeders in each hydronic system.

1. Provide in upright position with top of funnel not more than 48 inches above the floor.
2. Provide feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
3. Provide NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.

- C. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 6 feet per second, if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Provide temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the commissioning agent.
- D. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water. Circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.
- E. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.
- F. Close and fill system as soon as possible after final flushing to minimize corrosion. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
- G. Fill systems that glycol solutions to the concentrations indicated in the equipment schedules.

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. Provide blinds in flanged joints to isolate equipment.
5. Provide 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 to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 233113 - DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 8 for Access Doors
 - 2. Division 23 Section "Common Work Results"
 - 3. Division 23 Control Section
 - 4. Division 23 Section "Testing, Adjusting, and Balancing".

1.2 SUMMARY

- A. This Section includes ductwork and accessories.

1.3 SYSTEM DESCRIPTION

- A. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide necessary fittings and offsets. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions, which may be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
- B. The contractor must comply with the enclosed specification in its entirety. If on inspections, the engineer finds changes have been made without prior written approval, the contractor will make the applicable changes to comply with this specification, at the contractor's expense.
- C. At the discretion of the engineer, sheet metal gauges, and reinforcing may be randomly checked to verify duct construction is in compliance.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1. Exception: Sheet metal surfaces and fasteners.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Fittings.
4. Reinforcement and spacing.
5. Seam and joint construction.
6. Penetrations through fire-rated and other partitions.
7. Equipment installation based on equipment being used on Project.
8. Hangers and supports, including methods for duct and building attachment.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

D. Ductwork Specialties Product Data; provide for the following:

1. Sealant
2. Duct-mounted access doors and panels.
3. Flexible ducts.
4. Backdraft dampers.
5. Manual-volume dampers: Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling – examples: lighting fixtures, sprinklers, etc.
7. Areas of building where coordination drawings are required:
 - a. All Mechanical Rooms
 - b. All ductwork 24" wide and larger.
 - c. Congested areas

B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

C. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.8 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. National Fire Protection Association (NFPA)

1. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems
2. 96: Ventilation Control and Fire Protection of Commercial Cooking Operations

D. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

1. 3rd Edition: 2005 HVAC Duct Construction Standards, Metal and Flexible
2. 1st Edition: 2012 ANSI/SMACNA 016-2012 HVAC Air Duct Leakage Test Manual

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver sealant and fire stopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

- B. Deliver, store and handle materials according to manufacturer's written recommendations.
- C. All ductwork, equipment, and fittings delivered and stored on the job site must be capped to prevent the entry of moisture, construction dust or other debris.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA 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. Galvanized Coating Designation: G60 or G90 as indicated. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A-1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A-480/A-480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A-36/A-36M, steel plates, shapes, and bars; black and galvanized.
- G. 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.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of un-braced panel area, unless ducts are lined. All large ducts must be braced as required to prevent drumming.

E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

1. Fig. 2-3 Rectangular Elbows: Type RE2 square throat with vanes, Type RE1 radius (1.5W minimum), or Type RE5 dual radius. Square throat is not allowed.
2. Vane support in elbows: Fig 2-4. Turning vanes shall be double wall turning vanes fabricated from the same material as the duct. Mounting rails shall have friction insert tabs that align the vanes automatically. Tab spacing shall be as specified in Figure 2-3 of SMACNA. Rail systems with non-standard tab spacing shall not be accepted. Due to tensile loading, vanes shall be capable of supporting 250 pounds when secured according to the manufacturer's instructions.
3. Fig. 2-5 Rectangular Divided Flow Branches: Type 1, Type 2, Type 4A, or 4B.
4. Fig. 2-6 Branch Connections: 45-degree entry, 45-degree lead-in, bell-mouth or spin-in (single diffuser supply only).
5. Fig. 2-7 Offsets and Transitions. Use gradual offsets as shown, 90-degree offsets shall be avoided.
6. Fig 2-9 Duct Coils: Duct coils with transitions and upstream access door as shown.

2.3 ROUND DUCT FABRICATION

A. Fabricate supply ducts of galvanized steel according to SMACNA.

B. Longitudinal Seams: Select seam types and fabricate according to SMACNA Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

1. Exposed Round Ducts: Shall be Spiral Seam (RL-1 seam) at 2-inch wg construction.
2. Concealed Round Ducts: Shall be longitudinal Grooved Seam Flat lock (RL-5 seam) at 2-inch wg construction.
3. Snap lock seams shall not be used for this project.

C. Transverse Joints: Select joint types and fabricate according to SMACNA Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA.

2.4 HANGERS AND SUPPORTS

A. Hanger Rods: Cadmium-plated steel rods and nuts.

- B. Hanger Rods for Outdoor 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 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. 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.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. 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 SEALANT MATERIALS

- A. Joint Sealant/Mastic: Shall be flexible, water-based, adhesive sealant designed for use in all pressure duct systems. After curing, it shall be resistant to ultraviolet light and shall prevent the entry of water, air and moisture into the duct system. Sealer shall be UL 723 listed; UL 181A-M or 181B-M listed; and meet NFPA 90A requirements. Pressure sensitive tape shall not be used as a sealing mechanism.
 - 1. Maximum 5 flame spread and 0 smoke-developed (ASTM E-84 Tunnel Test).
 - 2. Generally, provide liquid sealant for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger.
 - 3. Resistance to mold, mildew and water: Excellent
 - 4. Color: Gray
 - 5. Duct sealant/mastic shall meet requirements for LEED. ITW TACC Miracle Kingco water-based sealants, or approved equal.
- B. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- C. Round Duct Joint O-Ring Seals: Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch w.g. and shall be rated for 10-inch w.g. static-pressure class, positive or negative. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 FITTINGS

- A. Tees, Laterals, and Conical Tees: Use 45 degree; fabricate to comply with SMACNA with metal thicknesses specified for longitudinal seam straight duct.
- B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.
- C. Elbows: Diameters 3 through 8 inches shall be two-section die stamped; all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
- D. Low-point drains: Ductmate moisture drain with funnel collection design; $\frac{3}{4}$ " connection with drain fitting and cap.

2.7 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ductmate Industries, Inc.
 2. Greenheck Fan Corporation.
 3. McGill Air Flow LLC.
 4. Nailor Industries Inc.
 5. Durodyne
 6. Cesco
 7. Buckley
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 1. Door: Double wall, rated for up to 4.5" static pressure. Door panel filled with 1" fiberglass insulation; $\frac{3}{4}$ lb. density. Hinges and Latches: 1-by-1-inch continuous piano hinge and cam latches. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs.
 3. Provide 1/8" thick neoprene gaskets.
 4. Locks: Access doors less than 12 sq. inches: One cam lock. Doors over 12 sq. inches shall have two locks.

2.8 FLEXIBLE CONNECTORS

- A. Provide for all air moving equipment. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with NFPA 90A. Factory fabricated with a strip of fabric 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 aluminum sheets. Select metal compatible with connected ducts. Duro-Dyne, Ductmate, Hardcast, or approved equal.

B. Indoor Flexible Connector Fabric: Glass fabric double coated with polychloroprene or neoprene. Minimum Weight: 26 oz. /sq. yd. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.

2.9 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 0 or 1. Flame Spread: Less than 25; Smoke Developed: Less than 50.

B. All products shall be certified by Greenguard Environmental Institute; independent testing of products for emissions of respirable particles and Volatile Organic Compounds (VOC's), including formaldehyde and other specific product-related pollutants. Greenguard provides independent, third-party certification of IAQ performance. Certification is based upon criteria used by EPA, OSHA and WHO.

C. Rated Positive Pressure: 10" w.g. per UL-181. Maximum negative pressure: $\frac{3}{4}$ ".

D. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing glass-fiber insulation around a continuous inner liner.

1. R6 insulation, Basis of Design: Atco #86
2. Reinforcement: Steel-wire helix encapsulated in inner liner.
3. Jacket (inner and outer): Polyethylene film.

E. Exhaust/Return Flexible Ducts, not insulated: Atco#50 Factory-fabricated, round duct. Reinforcement: Triple lamination of tough metallized polyester, aluminum foil and polyester encapsulates a steel wire helix. Rated for $\frac{3}{4}$ " w.g. negative pressure.

F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches to suit duct size.

G. Hangers shall be band type, 1" wide minimum.

2.10 MANUAL-VOLUME DAMPERS

A. Manual balancing dampers meeting the following specifications shall be furnished and installed on all branch ducts and where shown on plans. Testing and ratings to be in accordance with AMCA Standard 500-D.

B. Single-Blade Rectangular Dampers shall consist of: an 18 ga. galvanized steel frame with 3-1/2 in. depth; blades fabricated from 20 ga. galvanized steel; integral 1/2 in. diameter axles. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD-10.

- C. Multi-Blade Rectangular Dampers shall consist of: a 16 ga. galvanized steel hat channel frame with 5 in. depth; triple V type blades fabricated from 16 ga. galvanized steel; $\frac{1}{2}$ in. dia. plated steel axles; external (out of the airstream) blade-to-blade linkage. Damper suitable for pressures to 4.0 in. w.g. (996 Pa), velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBD15.
- D. Round dampers shall consist of: a 20 ga. galvanized steel frame with 6 in. depth; blades fabricated from 20 ga. galvanized steel; 3/8 in. square plated steel axles turning in acetal bearings. Damper suitable for pressures to 1.0 in. wg, velocities to 2000 fpm and temperatures to 180°F. Basis of design is Greenheck model MBDR50.

2.11 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Air Balance Inc.
 2. Cesco Products
 3. Greenheck Fan Corporation.
 4. Metalaire, Inc.
 5. Nailor Industries Inc.
 6. Prefco
 7. NCA
 8. Ruskin Company.
- B. Type: Static; rated and labeled according to UL 555S by an NRTL.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory-provided.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Provide replaceable fusible links with a temperature approximately 50°F above the maximum temperature that would normally be encountered within the system, but not less than 165°F.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION, GENERAL

- A. Provide volume dampers at branch ducts to RGD's. If volume dampers are inadvertently not shown, contractor shall provide, the intent is to provide volume dampers at branches.
- B. Provide ducts and accessories according to SMACNA unless otherwise indicated.
- C. Construct and install each duct system for the specific duct pressure classification indicated.
- D. Properly seam, brace, stiffen, support and render ducts mechanically airtight. Adjust ducts to suit job conditions. Dimensions may be changed as approved, if cross sectional area is maintained.
- E. Provide ducts in lengths not less than 12 feet, unless interrupted by fittings. Provide ducts with fewest possible joints.
- F. Provide fabricated fittings for changes in directions, changes in size and shape, and connections.
- G. Provide couplings tight to duct wall surface with a minimum of projections into duct.
- H. Provide ductwork to allow maximum headroom. Provide ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Provide ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Provide ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.
- K. Coordinate layout with suspended ceiling, lighting layouts, and similar finished work.
- L. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Exterior ductwork shall have a pitch of at least 3 degrees on the top, to allow water runoff, prevent ice buildup.

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Hangers Exposed to View: Threaded rod and angle or channel supports.

- C. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system. Seal duct joints to prevent dirt marks.
- D. 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.
- E. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- F. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 MATERIALS

- A. Hangers, accessories, and dampers shall be same material as parent duct.
- B. Ducts shall be G60 galvanized steel.
- C. Painted Exposed Ducts
 - 1. Painting shall be by Division 09.

3.4 DUCT CLASSIFICATIONS AND SEALING

- A. Static-Pressure Classifications: Unless otherwise indicated, construct ducts to the following:
 - 1. Supply duct upstream of VAV terminal units: 3 in. w.g.
 - 2. Supply Ducts downstream of VAV terminal units: 2-inch w.g.
 - 3. Return Ducts: 2-inch w.g, negative pressure.
 - 4. Exhaust Ducts: 2-inch w.g, negative pressure.
- B. Seam And Joint Sealing:
 - 1. Ductwork and plenums with pressure class ratings shall be constructed to Seal Class A. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage.
 - 2. Pressure-sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory, and the tape is used in accordance with that certification.
 - 3. Connections shall be sealed, including but not limited to spin-ins, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required.
 - 4. Spiral lock seams need not be sealed.
 - 5. Seal externally insulated ducts before insulation installation.

3.5 DUCT PENETRATIONS

- A. Fire or Smoke Rated Penetrations not requiring a fire and/or smoke damper: Where ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and fire dampers are not required, the opening in the construction around the duct shall be provided in accordance with the UL listing of the penetration. Provide firestopping per Section 230500.
- B. Fire or Smoke Rated Penetrations: Provide fire and/or smoke damper.
- C. Non-Fire-Rated Exposed Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.
- D. Non-Fire-Rated Concealed Penetrations: Provide insulation infill and acoustical sealant around gaps. Tightly seal to prevent sound transmission. Neatly finish.
- E. Mechanical room floor penetrations: Provide 4-inch high concrete curbs or other sealing method to prevent leakage from mechanical room into floor penetration.
- F. Flexible air ducts or connectors shall not pass through any wall, floor, or ceiling.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA Chapter 5, "Hangers and Supports."
- B. Building Attachments: Comply with SMACNA Chapter 5, "Hangers and Supports". Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
- C. Hanger Spacing: Comply with SMACNA 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. 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.
- E. Provide upper attachments to structures. Select and size upper attachments with pull-out, tension,

3.7 FLEXIBLE DUCT

- A. Provide in accordance with manufacturer's and SMACNA recommendations.
- B. Flexible ducts shall be supported at manufacturer's recommended intervals, but at no greater distance than 5 feet. Maximum permissible sag is $\frac{1}{2}$ " per foot of spacing between supports.
- C. Provide duct fully extended; do not install in the compressed state or use excess lengths.
- D. Avoid bending ducts across sharp corners or incidental contact with metal fixtures, pipes, conduits, or hot equipment.
- E. Bends shall be made with not less than 1 duct diameter centerline radius. Ducts shall extend a few inches beyond the end of a sheet metal connection before bending.
- F. Hanger or saddle material in contact with the duct shall be at least 1" wide.
- G. Provide at least 2 duct diameters of straight duct at the entrance to register, grilles, and diffusers.

3.8 DUCT ACCESSORIES INSTALLATION

- A. Provide duct accessories according to applicable details shown in SMACNA.
- B. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards
- C. Each register, grille, or diffuser shall have a means of air flow adjustment. Provide volume damper in branch duct if not furnished with the RGD.
- D. Adjust operable devices for proper action.
- E. Manual dampers shall be visible outside the insulation and marked with a 12" orange ribbon.
- F. Locate each duct smoke detector in a serviceable location, in accordance with its listing.
- G. Perform the following as directed by the controls contractor: Installation of control devices. Access doors where indicated and as required.
- H. Provide duct access panels for access components that require servicing.
 - 1. Provide duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining per equipment manufacturers' requirements.
 - 2. Provide access panels on side of duct where adequate clearance is available.
 - 3. Locate panel upstream and/or downstream as recommended by manufacturer.

4. Locations:
 - a. Upstream side of duct coils.
 - b. At outdoor-air intakes.
 - c. Adjacent to and close enough to life safety dampers, to reset or reinstall fusible links.
 - d. Control devices requiring inspection.
 - e. Elsewhere as indicated or required by duct accessory manufacturer
5. Inspect locations of access doors and verify that purpose of access door can be performed.

I. Control Damper Installation

1. Damper submittals shall be coordinated for type, quantity, and size to ensure compatibility with sheet metal design.
2. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting. Duct openings shall measure $\frac{1}{4}$ in. larger than damper dimensions and shall be square, straight, and level.
3. Individual damper sections, as well as entire multiple section assemblies, must be completely square and free from racking, twisting, or bending. Measure diagonally from upper corners to opposite lower corners of each damper section. Both dimensions must be within $\frac{1}{8}$ in. of each other.
4. Follow the manufacturer's instructions for field installation of control dampers. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
5. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, sections must open and close simultaneously.
6. Provide a visible and accessible indication of damper position on the drive shaft end.
7. Support ductwork in area of damper when required to prevent sagging due to damper weight.
8. After installation of low-leakage dampers with seals, caulk between frame and duct opening to prevent leakage around perimeter of damper.

J. Fire Damper Installation

1. Examine areas to receive dampers. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization of dampers. Do not proceed with installation until unsatisfactory conditions are corrected.
2. Provide dampers in accordance with manufacturer's UL Installation Instructions, labeling, and NFPA 90A at locations indicated on the drawings. Any damper installation that is not in accordance with the manufacturer's UL Installation Instructions must be approved prior to installation.
3. Dampers must be accessible to allow inspection, adjustment, and replacement of components. The sheet metal contractor shall furnish any access doors in ductwork or plenums required to provide this access. The general contractor shall furnish any access doors required in walls, ceilings, or other general building construction.

4. Provide dampers square and free from racking.
5. The installing contractor shall provide and install bracing for multiple section assemblies to support assembly weight and to hold against system pressure.
6. Do not compress or stretch the damper frame into the duct or opening.
7. Attach multiple damper section assemblies together in accordance with manufacturer's instructions. Provide support mullions as reinforcement between assemblies as required.
8. Handle dampers using the frame or sleeve. Do not lift or move dampers using blades, actuator, or jackshaft.
9. Provide access door, properly located for serving.
10. Tests and Inspections: Operate dampers to verify full range of movement and verify that proper heat-response device is installed.

3.9 PROTECTION

- A. 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."
 1. The HVAC system and ductwork shall be provided with protective coverings. The HVAC system includes any interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. This includes the entire duct from the points where the air enters the system to the points where the air is discharged from the system.
 2. The duct system shall be free of construction debris.
 3. The working area shall be clean, dry and the ductwork protected from dust.
 4. Protective coverings shall only be removed immediately before installation and inspected to determine if additional wipe down is necessary.
- B. Upon completion of installation duct systems and before HVAC system start-up, visually inspect the ductwork proper installation
- C. Cover supply openings with filter media prior to system start-up to catch any loose material that may remain inside the ductwork. Turn the HVAC system on and allow it to run until steady state operation is reached. Remove the temporary filter media from supply openings and, along with it, any loose material blown downstream and caught by the filter media.

3.10 FIELD QUALITY CONTROL

- A. Duct Leakage Tests
 1. Ductwork that is designed to operate at static pressures in excess of 3 in. of water and ductwork located outdoors shall be leak-tested according SMACNA Duct Leakage Test Procedures.
 2. Representative sections totaling no less than 25% of the total installed duct area for the designated pressure class shall be tested. All sections shall be selected by the building owner or the designated representative of the building owner. Positive pressure leakage testing is acceptable for negative pressure ductwork.

3. The maximum permitted duct leakage shall be:

$$L_{max} = C_L P^{0.65}$$

where

L_{max} = maximum permitted leakage, cfm per 100 ft² of duct surface area
 C_L = 4, duct leakage class, cfm per 100 ft² of duct surface area per in. of water^{0.65}
 P = test pressure, which shall be equal to the design duct pressure class rating, in. of water

4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
5. Test for leaks before applying external insulation.
6. 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.
7. Give seven days' advance notice for testing.
8. Submit a test report for each test. Documentation shall be provided demonstrating that representative sections totaling at least 25% of the duct area have been tested and that all tested sections comply
9. Duct system will be considered defective if it does not pass tests and inspections.

3.11 DUCT CLEANING

- A. Ducts shall be kept clean. If the contractor fails to maintain cleanliness, duct cleaning will be required, using duct cleaning methodology as indicated in NADCA ACR.

END OF SECTION 233113

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results"
 - 2. Division 23 Controls Section for control devices installed on air terminals.

1.2 SUMMARY

- A. This Section includes single-duct air terminals.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
 - 4. For adhesives and sealants, documentation including printed statement of VOC content.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings and schedules indicate requirements of air terminals and are based on specific systems indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

- B. Listing and Labeling: Provide electrically operated air terminals specified in this Section that are listed and labeled. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- C. Testing Requirements: Test and rate air terminals according to ARI 880, "Industry Standard for Air Terminals."
- D. Identification: Label each air terminal with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.
- E. NFPA Compliance: Provide air terminals according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- F. Comply with NFPA 70 for electrical components and installation.
- G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:
 - 1. Trane
 - 2. Titus
 - 3. Environmental Technologies.
 - 4. Price
 - 5. Metal Aire
 - 6. Krueger

2.2 SINGLE-DUCT AIR TERMINALS

- A. The unit casing shall be comprised of 22 gauge galvanized steel. Outlet connection shall be slip and drive. Basis of Design: Trane VariTrane Single-Duct VCCF – Cooling Only or Trane VCWF – With Hot Water Coil.
- B. Terminal units shall be ARI 880 - 98 certified and UL Listed.
- C. Casings: 22 gauge galvanized steel. Maximum casing leakage: 1.5 cfm at 1-inch w.g. inlet static pressure, certified ultra-low air leakage.
- D. 1" Double-wall Insulation—Interior surface of unit casing is acoustically and thermally lined with a 1-inch, 1.0 lb./ft³ composite density glass fiber with high-density facing. Insulation R-

value is 3.85. Insulation is UL listed and meets NFPA-90A and UL 181 standards. Insulation is covered by interior liner made of 26-gage galvanized steel. All wire penetrations are covered by grommets. There are no exposed edges of insulation (complete metal encapsulation).

- E. The air inlet connection shall be an 18 gauge galvanized steel cylinder sized to fit standard round duct. A multiple point, averaging flow sensing ring shall be provided with balancing taps for measuring within +/- 5% of unit cataloged airflow. Airflow versus pressure differential calibration chart shall be provided. The damper blade shall be constructed of a closed cell foam seal mechanically locked between two 22 gauge galvanized steel disks. The damper blade assembly shall be connected to a cast zinc shaft supported by self-lubricating bearings. The shaft shall be cast with a damper position indicator. The valve assembly shall include a mechanical stop to prevent over stroking. At 4.0" w.g. air valve leakage shall not exceed 1% of cataloged airflow.
- F. Hot Water Coil: Factory mounted on outlet. Provide full fin collars provided for accurate fin spacing and maximum fin-tube contact. The seamless copper tubes shall be mechanically expanded into the fin collars. Coils shall be proof tested at 450-psi and leak tested at 300-psi air pressure under water. Coil connections shall be sweat with left hand or right hand coil connections as per field constraints.
- G. Heating coils shall be provided with an access for cleaning. Provide access panels large enough for inspection, adjustment, and maintenance without disconnecting ducts, and for cleaning heating coils attached to unit Panels shall be insulated to same standards as the rest of the casing and shall be secured and gasketed airtight. It shall require no tool other than a screwdriver to remove.
- H. Controls: The terminals will have pressure independent direct digital controls supplied and mounted by the control contractor. Terminals shall be furnished with a pneumatic inlet velocity sensor. The sensor shall be multi-point center averaging type, with a minimum of four measuring ports parallel to the take-off point from the sensor. Sensors with measuring ports in series are not acceptable. The sensor must provide a minimum differential pressure signal of 0.03" wg at an inlet velocity of 500 fpm. Flow measuring taps and flow curves shall be supplied with each terminal for field balancing airflow. All pneumatic tubing shall be UL listed fire retardant (FR) type.
- I. Each terminal shall be equipped with labeling showing unit location, size, and scheduled cfm.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide air terminals level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards.
- B. Allow adequate clearance to meet NEC on control box side of unit to meet NEC.

- C. Support in accordance with SMACNA and manufacturer recommendations.
- D. Connect ductwork to air terminals according to Division 23 ductwork Sections. Slip each inlet duct over the inlet collar of the terminal. Fasten and seal the connection airtight. The diameter of the inlet duct must be equal to the listed size of the terminal.
- E. Inlet and outlet duct must be installed in accordance with SMACNA guidelines. Locate air terminal units to provide a straight section of inlet duct for proper functioning of volume controls. Provide a minimum of 2.5 equivalent duct diameters of straight duct at the inlet.

3.2 CONNECTIONS

- A. Provide piping adjacent to air terminals to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, and union; and to return with control valve, balancing valve and union.
- C. Electrical: Comply with applicable requirements in Division 26 Sections. Ground equipment. 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.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
 3. 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.
- B. Air terminal unit will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - 3. Verify that controls and control enclosure are accessible.
 - 4. Verify that control connections are complete.
 - 5. Verify that nameplate and identification tag are visible.
 - 6. Verify that controls respond to inputs as specified.

3.5 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 23 Section "Common Work Results"
 - 2. Division 23 Section "Ductwork"
 - 3. Division 23 Section "Testing, Adjusting, and Balancing"

1.2 SUMMARY

- A. This Section includes diffusers, registers (combination grille & damper), and grilles.

1.3 SUBMITTALS

- A. Each manufacturer shall check noise level ratings for registers and diffusers to insure that the sizes selected will not produce noise to exceed 30 db, "A" scale, measured at occupant level; notify Owner's representative of problems prior to shop drawing submittal.
- B. Pressure drop, airflow and noise criteria selection are based on design equipment. Manufacturers not submitting design makes must provide written certification in front of submittal that equipment submitted has been checked against and performs equal to the design make.
- C. Product Data: For each model indicated, include the following:
 - 1. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
 - 2. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
 - 3. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
 - 4. Assembly Drawing: For each type of air outlet and inlet; indicate materials and methods of assembly of components.
- D. Coordinate locations with reflected ceiling plans and wall elevations as applicable.
- E. Coordinate mounting frame with associated mounting surface.

1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A.
- B. Sound pressure levels shall be determined by using AHRI Standard 885-2008 "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Outlets".
- C. Testing: Test performance according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 2 - PRODUCTS

2.1 GENERAL

- A. Diffusers, registers, and grilles are scheduled on Drawings.
- B. Border and mounting type shall match the mounting surface. Coordinate with mounting conditions.
- C. Material shall match the specified ductwork. Coordinate with Section 233113 "Ductwork".
- D. Provide with a White Powder Coat finish, unless noted otherwise.
- E. Grille blade orientation: Vertical rectangle (wall grille with height longer than width): The blades shall run parallel to the short dimension of the grille. Horizontal rectangle: The blades shall run parallel to the long dimension of the grille.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Price
 2. Titus
 3. Metal-Aire
 4. Anemostat
 5. Nailor

2.3 RETURN OR EXHAUST

- A. Return/Exhaust Grille, 45-degree deflection
 1. Material: steel (Price 530 Series) or aluminum (Price 630 Series)
 2. Provide damper as scheduled.
 3. Grilles shall be 45 degree deflection fixed louver type with blades spaced 3/4" on center.

2.4 SUPPLY

A. Modular Louvered Face Diffusers

1. Material: steel (Price Model SMDA)
2. Air pattern shall be 1-way, 2-way, 3-way, or 4-way as scheduled.
3. Outer frame assembly, which facilitates mounting.
4. Integral collar that allows connection to the square or rectangular duct. Provide a square to round adaptor as scheduled.
5. Inner core assembly consisting of fixed louvers capable of producing the airflow discharge pattern as indicated on the project plans and shall be fully removable from the installed diffuser frame for access to any dampers or other ductwork components located in or near the diffuser neck.
6. The inner core assemblies shall be identically constructed so that directional core assemblies providing different airflow discharge patterns may be interchanged between frames if the frame duct connections are the same size.
7. The diffuser shall be supplied with a set of pattern deflectors to allow field adjustment of the air pattern from horizontal to vertical airflow.
8. The diffuser shall be supplied with an aperture style volume flow damper. The damper shall be manually adjustable from the diffuser face.

PART 3 - EXECUTION

3.1 INSTALLATION

- 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. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Provide diffusers, registers, and grilles level and plumb, according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- C. Drawings indicate general arrangement of ducts, fittings, and accessories. Make final locations where indicated, as much as practicable.
 1. For units installed in lay-in ceiling panels, locate units in the center of the panel.
 2. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- D. Provide diffusers, registers, and grilles with airtight connection to ducts.
- E. Provide 18" minimum of vertical straight ductwork at the entrance to ceiling diffusers.
- F. Plenum boxes on grilles/registers shall be 8" minimum height.

3.2 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.
- B. Adjustable outlets: adjust pattern for draft-free air distribution.

3.3 CLEANING

- A. Protect unit interiors from moisture, construction debris and dust, and other foreign materials. Comply with Section 233113 "Ductwork" Paragraph: Field Quality Control.
- B. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 233713

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire.
2. Metal-clad cable, Type MC.
3. Connectors and splices.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

D. Conductor Insulation:

1. Type THHN and Type THWN-2. Comply with UL 83.
2. Type XHHW-2. Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2. Comply with UL 1569.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:

1. Single circuit and multicircuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Insulated.

F. Conductor Insulation:

1. Type TFN/THHN/THWN-2. Comply with UL 83.
2. Type XHHW-2. Comply with UL 44.

G. Armor: Steel, interlocked.

2.3 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: Two hole with standard barrels.
3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors must be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Copper:

a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway, Metal-clad cable, Type MC.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway, Metal-clad cable, Type MC.
- G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533.13 "Conduits for Electrical Systems" prior to pulling conductors and cables.
- C. 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.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables accordingly.
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

END OF SECTION 260519

SECTION 260533.13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT-S duct raceways and elbows.
2. Type LFMC duct raceways.
3. Fittings for conduit, tubing, and cable.

B. Related Requirements:

1. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).

1.2 DEFINITIONS

A. Conduit: A structure containing one or more duct raceways.

B. Duct Raceway: A single enclosed raceway for conductors or cable.

PART 2 - PRODUCTS

2.1 TYPE EMT-S DUCT RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FJMX; including UL 797.

B. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Material: Steel.
2. Options:

- a. Exterior Coating: Zinc.
- b. Interior Coating: Zinc with organic top coating.
- c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- d. Colors: As indicated on Drawings.

2.2 TYPE LFMC DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DXHR; including UL 360.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

1. Material: Steel.
2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Colors: As indicated on Drawings.

2.3 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL FKAV - Fittings for Type EMT Duct Raceways:

1. Listing Criteria: UL CCN FKAV; including UL 514B.
2. Options:
 - a. Material: Steel.
 - b. Coupling Method: Compression coupling.
 - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

D. UL DXAS - Fittings for Type LFMC and Type LFNC Duct Raceways:

1. Listing Criteria: UL CCN DXAS; including UL 514B.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.
- B. Indoors:
 1. Concealed in Ceilings and Interior Walls and Partitions: EMT.
- C. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 1. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
 2. Type LFMC: Article 350 of NFPA 70 and NECA NEIS 101.
 3. Expansion Fittings: NEMA FB 2.40.
 4. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
 1. Stub-ups to Above Recessed Ceilings:
 - a. Provide EMT, IMC, or ERMC for duct raceways.
 - b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
 2. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
 - a. EMT: Provide compression, steel fittings. Comply with NEMA FB 2.10.
 - b. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.
 3. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.

- a. Provide warning signs.

D. Interfaces with Other Work:

- 1. Coordinate installation of new products with existing conditions.

3.3 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533.13

SECTION 260533.16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Concrete Floor Boxes

PART 2 - PRODUCTS

2.1 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QCIT; including UL 514A.

B. UL QCIT - Metallic Outlet Boxes and Covers:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
2. Options:

- a. Material: Sheet steel.
- b. Sheet Metal Depth: Minimum 2 inch.

C. UL QCIT - Metallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.

D. UL QCIT - Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.

2. Options:
 - a. Material: Sheet steel.
 - b. Sheet Metal Depth: minimum 2 inch.
- E. UL QCIT - Metallic Extension Rings:
 1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

2.2 JUNCTION BOXES AND PULL BOXES

- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. Listing Criteria: UL CCN BGUZ; including UL 50 and UL 50E.
- B. UL BGUZ - Indoor Sheet Metal Junction and Pull Boxes:
 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 2. Options:
 - a. Degree of Protection: Type 1.

2.3 COVER PLATES FOR DEVICES BOXES

- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. Listing Criteria: UL CCN QCIT or UL CCN QCMZ; including UL 514D.
 3. Wallplate-Securing Screws: Metal with head color to match wallplate finish.
- B. UL QCIT or QCMZ - Nonmetallic Cover Plates for Device Boxes:
 1. Options:
 - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
 - b. Wallplate Material: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device.
 - c. Color: White.

2.4 Concrete Floor Boxes

- A. Concrete Floor Boxes General: Comply with NEMA OS 1 and are both UL and CUL listed for power, audio, video, telecommunications and data.
- B. Concrete Floor Box Kits: 8 inch Fire Rated Poke-Through:
 - 1. 2 hour fire rating.
 - 2. 180 degree access door opening.
 - 3. Flange height 0.15 inch and complies with ADA requirements.
 - 4. Power wiring junction box included.
 - 5. Complies with UL514A for scrub water test.
 - 6. 1000 lb. cover load rating with 2 x safety factor.
 - 7. UL rated.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.
- B. Degree of Protection:
 - 1. Indoors:
 - a. Type 1 unless otherwise indicated.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 - 1. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
 - 1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
 - 2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

3. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
4. Locate boxes so that cover or plate will not span different building finishes.
5. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
6. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
7. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
8. Set metal floor boxes level and flush with finished floor surface.
9. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
10. Identification: Provide labels for boxes and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Provide warning signs.
 - c. Label each box with engraved metal or laminated-plastic nameplate.

D. Interfaces with Other Work:

1. Coordinate installation of new products with existing conditions.

3.3 PROTECTION

A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260533.16

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchbox-mounted occupancy sensors.
2. Daylight-harvesting controls.
3. Business occupancy and vacancy sensors.
4. Emergency lighting controls.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

1.3 WARRANTY

A. Special Extended Warranty: Manufacturer and Installer warrant that installed lighting control devices perform in accordance with specified requirements and agree to repair or replace, including labor, materials, and equipment, devices that fail to perform as specified within extended warranty period.

1. Failures include, but are not limited to, the following:

- a. Faulty operation of lighting control software.
- b. Faulty operation of lighting control devices.

2. Extended Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox using hardwired connection.

1. Listed and labeled in accordance with NFPA 70, by a qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800 VA LED load at 120 V, 1200 VA LED load at 277 V, and 800 W incandescent.

2.2 DAYLIGHT-HARVESTING CONTROLS

A. UL WJCT - Daylight-Harvesting Digital Control Dimmer:

1. Source Limitations: Obtain products from single manufacturer.
2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Photoelectric Switches: UL CCN WJCT, including UL 773A.
3. Standard Features:
 - a. Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, lights are dimmed.
 - b. System programming is done with two handheld, remote-control tools:
 - 1) Initial setup tool.
 - 2) Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
 - c. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate power pack, to detect changes in indoor lighting levels that are perceived by the eye.
 - d. Sensor Output: 0-10 V(dc) to operate luminaires. Sensor is powered by controller unit.
 - e. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.
4. Sequence of Operation: Lighting control set point is based on the following two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.

2.3 BUSINESS OCCUPANCY AND VACANCY SENSORS

A. Dual-Technology, Passive-Infrared (PIR) and Ultrasonic, Occupancy or Vacancy Sensor:

1. Source Limitations: Obtain products from single manufacturer.

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for one of the following UL product categories:
 - a. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
 - b. Appliance Controls: UL CCN ATNZ, including UL 60730-1.
 - c. Intrusion Detection Units: UL CCN ANSR, including UL 639.
3. Standard Features:
 - a. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 - b. Separate power pack.
 - c. Hardwired connection to lighting control system.
 - d. Sensitivity Adjustment: Separate for each sensing technology.
 - e. Detector Sensitivity: Detect occurrences of 6 inch minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch, and detect a person of average size and weight moving not less than 12 inch in either a horizontal or a vertical manner at an approximate speed of 12 inch/s.
 - 1) Detection Coverage (Ceiling Mounted): Detect occupancy anywhere within a circular area of 2000 sq. ft when mounted on a 96 inch high ceiling.
 - 2) Detection Coverage (Wall Mounted): Detect occupancy anywhere within a half circular area of 1000 sq. ft when mounted at 96 inch above the floor.

2.4 EMERGENCY LIGHTING CONTROLS

- A. UL FTBR - Automatic Load Control Relay:
 1. Source Limitations: Obtain products from single manufacturer.
 2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:
 - a. Emergency Lighting and Power Equipment: UL CCN FTBR, including UL 924.
3. Standard Features:
 - a. N.C., electrically held relay.

PART 3 - EXECUTION

3.1 INSTALLATION OF SENSORS

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's instructions.

3.2 INSTALLATION OF CONTACTORS

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 INSTALLATION OF WIRING

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's instructions.
- C. Size conductors in accordance with lighting control device manufacturer's instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, device, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring in accordance with Section 260553 "Identification for Electrical Systems."
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Nonconforming Work:

1. Lighting control devices will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

END OF SECTION 260923

SECTION 262726.33 - GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Duplex straight-blade receptacles.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Duplex straight-blade receptacles.

PART 2 - PRODUCTS

2.1 DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Description: General-grade duplex receptacles for use in wiring systems recognized by NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

- a. Reference Standards:

- 1) UL CCN RTRT and UL 498.
- 2) Surge Protective Devices: UL 1449, Type 3.

C. Duplex Straight-Blade Receptacle:

1. Options:

- a. Device Color: White.
- b. Configuration: NEMA 5-20R.

2. Accessories:

- a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
- b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION

- A. Comply with manufacturer's instructions.

- B. Reference Standards:

1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
4. Consult Architect for resolution of conflicting requirements.

- C. Identification:

1. Identify cover or cover plate for device with panelboard identification and circuit number.

3.3 PROTECTION

- A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
- B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726.33

SECTION 262726.37 - RECEPTACLES WITH GROUND-FAULT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles with GFCI devices.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Receptacles with GFCI devices.

B. Field quality-control reports.

1.3 WARRANTY

A. Special Manufacturer Extended Warranty: Manufacturer warrants that devices perform in accordance with specified requirements and agrees to provide repair or replacement of devices that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Three years from date of Substantial Completion; coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 RECEPTACLES WITH GFCI DEVICES

A. Description: Receptacles containing GFCI device for use in accordance with NFPA 70.

B. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. General Characteristics:

- a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
- C. General-Grade, Weather-Resistant, Tamper-Resistant Duplex Straight-Blade Receptacle with GFCI Device:
 - 1. Options:
 - a. Device Color: Ivory.
 - b. Configuration: Heavy-duty, NEMA 5-20R.
 - 2. Accessories:
 - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION

- A. Comply with manufacturer's instructions.

- B. Reference Standards:

- 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
- 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
- 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
- 4. Consult Architect for resolution of conflicting requirements.

- C. Identification:

- 1. Identify cover or cover plate for device with panelboard identification and circuit number.
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

- D. Interfaces with Other Work:

1. Do not install Type 3 SPD, including surge-protected relocatable taps and power strips, on branch circuit downstream of GFCI device.
2. Coordinate installation of new products with existing conditions.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Insert and remove test plug to verify that device is securely mounted.
2. Verify polarity of hot and neutral pins.
3. Measure line voltage.
4. Measure percent voltage drop.
5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

3.4 PROTECTION

- A. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
- B. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 262726.37

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following types of LED luminaires:
 1. Downlight.
 2. Surface mount, linear.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 2. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

1.3 QUALITY ASSURANCE

- A. Provide luminaires from a single manufacturer for each luminaire type.
- B. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.4 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

2.2 DOWNLIGHT

A. Nominal Operating Voltage: See schedule.

B. Lamp:

1. Minimum 1000 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. CRI of minimum 80.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to zero percent of maximum light output.
6. Internal driver.

C. Housings:

1. Extruded-aluminum housing and heat sink.
2. Universal mounting bracket.
3. Integral junction box with conduit fittings.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. Recessed luminaires shall comply with NEMA LE 4.

2.3 SURFACE MOUNT, LINEAR

A. Nominal Operating Voltage: See schedule.

B. Lamp:

1. Minimum 1800 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. CRI of minimum 80.
4. Rated lamp life of 50,000 hours to L70.
5. Dimmable from 100 percent to zero percent of maximum light output.
6. Internal driver.
7. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

C. Housings:

1. Extruded-aluminum housing and heat sink.
2. With integral mounting provisions.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:

1. Prismatic acrylic.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.4 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. Aluminum: ASTM B209.

2.5 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 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 weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- E. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals.

3.3 FIELD QUALITY CONTROL

- A. 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.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.

END OF SECTION 265119

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Optical-fiber-cable pathways and fittings.
3. Boxes, enclosures, and cabinets.

1.2 ACTION SUBMITTALS

A. Product data for each type of product.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

C. EMT: Comply with ANSI C80.3 and UL 797.

D. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2. Fittings for EMT:

- a. Material: Steel.
- b. Type: compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

E. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum or general-use installation unless otherwise indicated.

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
5. Gangable boxes are prohibited.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

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

F. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

G. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Minimum Pathway Size: 1-inch trade size.
- B. Pathway Fittings: Compatible with pathways and suitable for use and location.
- C. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- D. Install surface pathways only where indicated on Drawings.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- E. Complete pathway installation before starting conductor installation.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- G. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

- H. Support conduit within 12 inches of enclosures to which attached.
- I. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- J. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- K. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- L. Mount boxes at heights indicated on Drawings. Install boxes with height measured to top of box unless otherwise indicated.
- M. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- N. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- O. Set metal floor boxes level and flush with finished floor surface.
- P. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.4 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Refer to specification Attachment 1 “MEARNG Conduit and Junction Box Color Coding” for Owner-specific conduit requirements.

1.2 SUMMARY

- A. Section Includes:

1. Labels.
2. Signs.
3. Cable ties.
4. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible labels with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 - 2. Marker for Labels:
 - a. Permanent, waterproof black ink marker recommended by tag manufacturer.
 - b. Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.4 SIGNS

- A. Baked-Enamel Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal Size: 7 by 10 inches.
- B. Laminated-Acrylic or Melamine-Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Self-adhesive.

- e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.5 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Verify identity of each item before installing identification products.

- C. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- D. Apply identification devices to surfaces that require finish after completing finish work.
- E. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- F. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- G. Vinyl Wraparound Labels:
 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 3. Provide label 6 inches from cable end.
- H. Snap-Around Labels:
 1. Secure tight to surface at a location with high visibility and accessibility.
 2. Provide label 6 inches from cable end.
- I. Self-Adhesive Wraparound Labels:
 1. Secure tight to surface at a location with high visibility and accessibility.
 2. Provide label 6 inches from cable end.
- J. Self-Adhesive Labels:
 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- K. Cable Ties: General purpose, except as listed below:
 1. Outdoors: UV-stabilized nylon.
 2. In Spaces Handling Environmental Air: Plenum rated.
- L. Handwritten identification materials are unacceptable.

3.2 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- C. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:
 - 1. Wiring closet designation.
 - 2. Colon.
 - 3. Faceplate number.
- D. Equipment Room Labeling:
 - 1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
 - 2. Patch Panels: Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.
 - 3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
 - a. Room number being served.
 - b. Colon.
 - c. Faceplate number.
- E. Backbone Cables: Label each cable with a self-adhesive wraparound indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- F. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:
 - 1. Room number.
 - 2. Colon.
 - 3. Faceplate number.
- G. Instructional Signs: Self-adhesive labels.
- H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.
 - 1. Apply to exterior of door, cover, or other access.
- I. Equipment Identification Labels:
 - 1. Indoor Equipment: Self-adhesive label.
 - 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.
 - 3. Equipment to Be Labeled:
 - a. Communications cabinets.
 - b. Uninterruptible power supplies.

- c. Computer room air conditioners.
- d. Fire-alarm and suppression equipment.
- e. Egress points.
- f. Power distribution components.

END OF SECTION 270553

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Category 6 twisted pair cable.
 - 2. Twisted pair cable hardware, including plugs and jacks.
 - 3. Cable management system.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Twisted pair cable testing plan.
- C. Twisted pair cable testing results.

1.3 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated:

- a. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.
- B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- C. Conductors: 100-ohm, 23 AWG solid copper.
- D. Shielding/Screening: Unshielded twisted pairs (UTP).
- E. Cable Rating: Plenum.
- F. Jacket: Blue or Green thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- D. Connecting Blocks:
 - 1. 110-style IDC for Category 6.
 - 2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
- F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - 2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
 - 3. Number of Jacks per Field: One for each four-pair cable indicated.
- G. Patch Cords: Factory-made, four-pair cables; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.
 - 3. Jacket: Blue or Green thermoplastic.
 - 4. Length: As noted on drawings.
- H. Plugs and Plug Assemblies:
 - 1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Standard: Comply with TIA-568-C.2.
 - 3. Marked to indicate transmission performance.
- I. Jacks and Jack Assemblies:
 - 1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 - 2. Designed to snap-in to a patch panel or cover plate.
 - 3. Standard: Comply with TIA-568-C.2.
 - 4. Marked to indicate transmission performance.
- J. Cover Plate:
 - 1. Four port, vertical single gang cover plates designed to mount to single gang wall boxes.
 - 2. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 260533.16 "Boxes and Covers for Electrical Systems."
 - 3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

PART 3 - EXECUTION

3.1 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. Routing: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
 1. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.
- D. General Requirements for Cabling:
 1. Comply with TIA-568-C.1.
 2. Comply with BICSI's Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
 3. Install 110-style IDC termination hardware unless otherwise indicated.
 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 9. 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.
 10. Cold-Weather Installation: Bring cable to room temperature before derricking. Heat lamps shall not be used for heating.
 11. In the communications equipment room, install a 10-foot-long service loop on each end of cable.

12. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
 1. 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.

3.2 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.3 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- C. Comply with TIA-607-B and NECA/BICSI-607.
- D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.4 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.

- C. Equipment grounding conductors.
- D. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.5 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - 4. Perform Category 6 link tests in accordance with TIA-568.1 and TIA-568.2. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.
- B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

C. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

D. Collect, assemble, and submit test and inspection reports.

END OF SECTION 271513